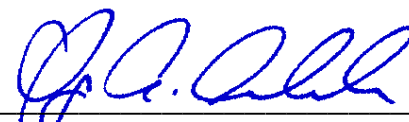


Expert Report of Gary A. Amendola, P.E.

United States and State of Louisiana v. CITGO Petroleum Corporation
Civil Action No. 2:08-cv-893



Gary A. Amendola, P.E.

December 14, 2009



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A. Statement of Qualifications

I am Gary A. Amendola, P.E., president of Amendola Engineering, Inc., an environmental engineering and consulting firm I founded in 1989. My educational background is in the area of environmental sciences and engineering. I was awarded a Bachelor of Science degree in Environmental Engineering from the Rensselaer Polytechnic Institute in 1969.

The principal environmental issues in this matter involve process wastewater and storm water management, spill prevention and control and compliance with Louisiana Pollutant Discharge Elimination System (LPDES) permit requirements, air emission and hazardous waste regulations.¹ As described below I have had direct and responsible experience in each of these areas across a number of industrial sectors.

My professional career spans forty years including two years as an environmental engineer with the BFGoodrich Chemical Company of Cleveland, Ohio; eighteen years with the U.S. Environmental Protection Agency in a variety of capacities; and, twenty years as a consulting engineer and president of Amendola Engineering, Inc.

At BFGoodrich I focused primarily on process wastewater management and treatment at a petrochemical manufacturing complex (mercury-cell chlor-alkali; acrylonitrile; ethylene; ethylene dichloride; vinyl chloride monomer) and at polyvinyl chloride (PVC) manufacturing plants.

I had extensive experience in the national effluent limitations guidelines and NPDES permit and pretreatment programs throughout my public service career at EPA. I prepared and supervised engineers and scientists who prepared NPDES permits for some of the nation's most complex major discharge manufacturing facilities in the chemicals, iron and steel and metals industries, as well as for coal-fired steam-electric generating facilities and petroleum refineries. I was appointed Senior Iron and Steel Industry Specialist for EPA's Office of Water Regulations and Standards and was instrumental in EPA's promulgation of national effluent limitations guidelines and standards for the iron and steel manufacturing point source category in 1982 (40 CFR Part 420). While at EPA I managed complex regional studies of dioxins (CDDs/CDFs) and a pioneering national study of dioxin formation at bleached Kraft pulp and paper mills. I received the Federal Environmental Engineer of the Year award in 1988 from the Council of Federal Environmental Engineers; the EPA's Administrator's Award for Excellence in Management; a Gold Medal for Exceptional service and a number of other EPA awards.

Over the past twenty years Amendola Engineering has provided consulting services for NPDES permit renewals, prepared Spill Prevention Control and Countermeasure (SPCC) Plans and prepared Storm Water Pollution Prevention Plans (SWPPP) for manufacturing facilities in the chemicals, iron and steel and metals industries. We provided third-party multi-media environmental auditing services for private sector clients in the chemicals and metals industries.

¹ In Louisiana, permits issued by the Louisiana Department of Environmental Quality (LDEQ) under the National Pollutant Discharge Elimination System (NPDES) permit program are called Louisiana Pollutant Discharge Elimination System (LPDES) permits.

I provided consulting services in 1992 to the Ministry of Energy in Trinidad and Tobago for process wastewater and storm water management for petroleum refineries and for on shore oil and gas facilities. I served as an expert consultant to the Ontario Ministry of Environment for developing Ontario's MISA best available technology economically achievable (BAT/EA) effluent guidelines for the Ontario iron and steel, organic chemicals and petroleum refining sectors.

Amendola Engineering has been providing NPDES and storm water permit compliance assistance to the California Regional Water Quality Control Boards for the past eight years. As part of this effort Amendola Engineering personnel under my direction completed approximately 200 NPDES permit compliance evaluation inspections at municipal, industrial and federal facilities. Approximately 30 of those inspections were at petroleum refineries. I have been providing consulting services for advanced physical/chemical and biological process wastewater treatment for steel mills located in the United States and to engineering firms and a Brazilian steel company for design and construction of a new source steel mill in Brazil.

Exhibit A is a copy of my *curriculum vitae* (c.v.), a list of my publications and billing information. I have not provided testimony in a deposition or at trial during the past four years.

B. Assignment

I have been asked to examine the following for the CITGO Petroleum Corporation Lake Charles Manufacturing Complex (CITGO):

- CITGO's wastewater management from the 1980's until June 2006, when CITGO experienced a massive release of waste oil and untreated petroleum refinery wastewaters during a storm event;
- Circumstances leading to the June 2006 release and principal causes of the release;
- CITGO's compliance record with respect to its LPDES permit effluent limits; and,
- Measures taken by CITGO after the June 2006 release and current CITGO wastewater management systems and operating practices.

I have been asked to offer my opinions in six areas: (1) principal causes of the June 2006 waste oil and untreated oily wastewater release; (2) measures CITGO should have taken to provide adequate wastewater management and treatment prior to the June 2006 release; (3) whether CITGO exercised reasonable care in designing, constructing and operating its wastewater storage and wastewater treatment facilities; (4) whether CITGO's current wastewater collection, storage and treatment facilities and operating practices are adequate to prevent releases from the wastewater collection and storage systems while maintaining compliance with CITGO's LPDES permit and related environmental regulations; (5) costs CITGO avoided or delayed for facilities and measures that should have been implemented prior to the June 2006 release; and (6) needed corrective actions.

I considered and relied on the documents referenced in this report with Bates numbers or by footnote, as well as other Bates-numbered documents and depositions produced by the parties. Exhibit B is a list of other reference materials upon which I relied to form my opinions in this matter. I hold my opinions to a reasonable degree of engineering and scientific certainty. I reserve the right to supplement my opinions and amend this report based on new information and further review of the record in this matter.

C. Findings/Opinions/Conclusions

1. CITGO Lake Charles Manufacturing Complex records show that on June 19, 2006 CITGO overflowed from 99,000 to as much as 135,000 barrels (4,200,000 to 5,700,000 gallons) of waste oil and approximately 411,000 barrels (17,300,000 gallons) of untreated oily refinery wastewaters from two storm water/wastewater (wastewater) storage tanks to a breached secondary containment dike for the wastewater storage tanks. CITGO reported that 53,000 barrels (2,226,000 gallons) of waste oil and approximately 259,500 barrels (10,900,000 gallons) of untreated oily petroleum refinery wastewaters were subsequently discharged to the Indian Marais. CITGO petroleum refinery waste oils contain hazardous substances including benzene and polynuclear aromatic hydrocarbons. CITGO's untreated refinery wastewaters contain waste oil, a number of pollutants designated as toxic under the Clean Water Act and a number of substances designated as hazardous under the Resource Conservation and Recovery Act (RCRA).
2. The generally accepted industry design storm for storm water management and for secondary containment capacity for bulk oil storage tanks is the 24-hour storm with a 25-year recurrence interval (25-year/24-hour storm). For the Lake Charles area the rainfall intensity for the 25-year/24-hour storm is 10.25 inches. The June 2006 CITGO release occurred during an intense rainfall event (8.3 inches) that was within design standards CITGO selected for the wastewater storage and wastewater treatment systems it installed in May 1994. Lack of adequate wastewater storage capacity and lack of proper operation and maintenance of two wastewater storage tanks were the principal causes of the June 2006 release. Despite the wastewater storage tank design and CITGO's standard operating procedures for the wastewater storage tanks, CITGO accumulated excessive amounts of waste oil and waste solids in the wastewater storage tanks for several years prior to the June 2006 release. Given the design of the wastewater storage tank system, reasonable operation and maintenance would have been removal of the waste oil and waste solids on a more or less continuous basis.
3. During the design process for the wastewater storage tanks and wastewater treatment system CITGO commissioned in May 1994, CITGO made a fundamental decision to collect, mix and co-treat contaminated and uncontaminated storm waters from a considerable portion of the site with untreated petroleum refinery process wastewaters regulated by the federal petroleum refining categorical effluent limitations guidelines at 40 CFR Part 419 and CITGO's LPDES wastewater discharge permit. This fundamental decision directly affected the volume of wastewater storage capacity required, the size of the secondary containment structure for the wastewater storage tanks and the capacity of the end-of-pipe wastewater treatment system necessary to comply with the LPDES permit. Having made that decision, CITGO was obligated to install adequately sized wastewater storage tanks and wastewater treatment facilities in May 1994. It did not and instead opted to take a high risk design approach to wastewater storage and wastewater treatment.
4. CITGO's own internal risk assessment of wastewater storage system and wastewater treatment system cost reduction measures characterized several CITGO design decisions as high risk. CITGO records show that CITGO deleted from the initial installation in May 1994 approximately one-third of the design wastewater storage capacity and a number of critical wastewater treatment units for cost savings. The installed design did not provide for adequate wastewater storage and treatment units or allow for planned maintenance outages and unplanned outages of critical wastewater

storage and treatment units under reasonably anticipated wastewater flow conditions. Such equipment should have been installed in May 1994 in the exercise of reasonable engineering judgment.

5. During the design process for the wastewater storage tanks and wastewater treatment system commissioned in May 1994, CITGO commissioned an independent third-party review of the conceptual design being developed by its principal design engineering consultant. That review was provided to CITGO in July 1992. The review cited a number of potential problem areas in the conceptual design. CITGO was advised these problem areas could lead to future problems in detailed design, construction, operation or maintenance of the new wastewater storage and treatment systems. CITGO considered this review but apparently chose to ignore many of the salient warnings.
6. CITGO also failed to install certain wastewater pretreatment systems and failed to implement certain dry weather and wet weather flow reduction measures that were part of the design basis for the wastewater storage tanks and wastewater treatment system commissioned in May 1994. The wastewater pretreatment systems and dry weather and wet weather flow reduction measures should have been implemented as of May 1994 in the exercise of reasonable engineering judgment.
7. When it considered cost reduction measures for the May 1994 wastewater storage and treatment system CITGO initiated a “modular approach” to the installation of the treatment system whereby additional wastewater storage and treatment units would be added in the future. Plot space was reserved for a wastewater storage tank and a number of wastewater treatment units. However, CITGO cut the initial design below the bare minimum and the modular approach as outlined was not followed.
8. CITGO did not maintain and operate properly critical aspects of the wastewater storage and wastewater treatment systems it installed prior to the June 2006 waste oil and untreated oily wastewater release, namely the wastewater storage tanks and API oil/solids separators. During the five year period leading to the June 2006 release, CITGO did not maintain low sludge (waste solids) levels in the wastewater storage tanks as required by its standard operating procedure.
9. During at least the five year period leading to the June 2006 release, CITGO also allowed an estimated 99,000 up to 135,000 barrels (4,200,000 to 5,700,000 gallons) of waste oil to accumulate in the wastewater storage tanks. This effectively reduced substantially the already inadequate wastewater storage capacity and increased the risk of a major oil spill. If CITGO had not accumulated from 99,000 to 135,000 barrels (4,200,000 to 5,700,000 gallons) of waste oil in the wastewater storage tanks, the massive release of waste oil would have been avoided. Under any conditions and notably under conditions at CITGO at the time, accumulating that much waste oil in the storm water/wastewater storage tanks defies basic common sense.
10. CITGO’s shortfalls in installing adequate wastewater storage capacity and shortfalls in installing adequate numbers of treatment units in the wastewater treatment system contributed substantially to the June 2006 release and to wastewater treatment system operating problems that led to many exceedances of CITGO’s LPDES permit effluent limits. CITGO operated in a high risk mode over an extended period of time after May 1994. The risk grew over time as capacity in the wastewater storage tanks decreased and process wastewater flows increased with increased refinery operations. The June 2006 waste oil and untreated oily wastewater release and the LPDES permit

exceedances attributable to shortfalls in wastewater treatment system design and equipment could have been avoided had CITGO installed and operated properly adequate wastewater storage capacity and wastewater treatment facilities in May 1994. CITGO still does not have adequate wastewater storage and wastewater treatment capacity today.

11. CITGO needed more than 40 million gallons (MM gallons) of wastewater storage capacity when it installed its wastewater storage and treatment systems in May 1994, but installed less than 20 MM gallons of dedicated wastewater storage capacity in wastewater storage tanks T-320 and T-330, and limited additional wastewater storage in equalization tank T-310. CITGO had actual operating experience over at least three years after installing the May 1994 wastewater storage and wastewater treatment systems that confirmed the design shortfalls in wastewater storage capacity and wastewater treatment. CITGO received the results of a storm water risk assessment in 1998 that confirmed those design shortfalls. There were numerous requests and recommendations from CITGO staff and recommendations from CITGO consultants from 1995 to 2005 for additional wastewater storage capacity and upgrades to the wastewater treatment system. Yet, CITGO completed no significant upgrades until September 2005 when a third wastewater treatment clarifier was installed and until December 2007 when a third wastewater storage tank was put into service.
12. CITGO conducted a number of engineering studies and investigations following the June 2006 release and has implemented some corrective measures. However, CITGO's plan has been to use the wastewater storage tank secondary containment dike for diversion of untreated petroleum refinery wastewaters when shortfalls in wastewater storage capacity develop from high rainfall events and during maintenance periods when one or more wastewater storage tanks are out of service. This is in lieu of installing additional wastewater storage capacity which was recommended as the best option during 2007 by CITGO personnel and CITGO consultants to address a number of wastewater storage and wastewater treatment issues. CITGO's operating approach of diverting untreated oily wastewaters to the containment dike is not a reasonable alternative to providing adequate wastewater storage capacity in tanks. This approach raises issues of non-compliance with CITGO's LPDES permit; non-compliance with applicable benzene National Emission Standards for Hazardous Air Pollutants (NESHAPs); may result in benzene air releases in excess of reportable quantities under CERCLA; would cause hazardous wastes (F037, D018) to be deposited in the containment dike; and, would take away secondary containment capacity for the wastewater storage tanks that is required by the federal oil pollution prevention regulation (SPCC program).
13. Considering the nature of CITGO's untreated refinery wastewaters (high levels of waste oil, toxic pollutants and hazardous substances) and the risk of significant environmental releases of these materials, my opinion is that CITGO acted recklessly and well below standards of reasonable care in the design, construction and operation of its wastewater storage and wastewater treatment facilities going back to the early 1990's. CITGO documents reveal that CITGO assessed the risks of reducing the scope and the cost of its 1994 wastewater treatment project. By its own risk assessment, in at least six cases CITGO decided to take a high risk approach to the design rather than a prudent design approach that would have provided for the required amount of wastewater storage capacity and adequate numbers of critical wastewater treatment equipment units. CITGO's decisions during the design phase of the wastewater storage and wastewater treatment project were reckless.

14. This is not a case where CITGO installed robust wastewater storage and wastewater treatment systems that were overwhelmed by unforeseen events. Rather, this is a case where CITGO took a high risk approach to the engineering design of the wastewater storage and treatment systems in search of cost savings; failed to implement a number of pretreatment and flow reduction measures that the high risk design was predicated on; and, for years operated in a high risk mode by not operating properly some of the critical wastewater storage and wastewater treatment systems it did install. CITGO also failed to respond in a reasonable amount of time to operating problems and design shortfalls that were evident and confirmed soon after the wastewater treatment and storage system was commissioned in May 1994.

15. CITGO's reckless actions and major departures from reasonable care that led to the June 2006 release included:
 - Shortfall in the wastewater storage capacity installed initially in 1994. In 1987, one CITGO consultant recommended 37.8 million gallons (or MM gallons) of wastewater storage capacity and cited a maximum wastewater storage requirement of 47 million gallons. A second consultant in 1992 recommended 34 million gallons of wastewater storage capacity. A third consultant in 1992 cited the design basis as 41 million gallons of wastewater storage capacity in four wastewater storage/equalization tanks. CITGO at the time requested 44 million gallons to account for storage tank maintenance. For cost cutting reasons, CITGO ultimately installed in May 1994 less than 20 million gallons of dedicated wastewater storage capacity with wastewater storage tanks T-320 and T-330.

 - Lack of proper operation and maintenance of the wastewater storage tanks, particularly during the period 2000 to 2006. CITGO did not follow its own standard operating procedures for the storage tanks (T-320, T-330). Oil skimmers designed to remove waste oil from the wastewater storage tanks more or less on a continuous basis were not operated and not repaired or replaced. Eductors to assist in removing waste solids from the tanks were not operated. Waste oil and waste solids were allowed to accumulate in the wastewater storage tanks for five or more years prior to the June 2006 release, thus exacerbating the design shortfall in wastewater storage capacity and creating an increased risk of waste oil releases from the tops of the tanks. This shows a complete lack of care given the circumstances at the site. The storage tank design called for removal of accumulated waste oils and waste solids more or less on a continuous basis thus avoiding build-up over time. CITGO did not track the levels of waste oils in the wastewater storage tanks for several years before the June 2006 release.

 - Failure to install certain wastewater pretreatment systems and failure to implement a number of dry weather and wet weather flow reduction measures considered part of the final engineering design for the May 1994 treatment system. At this writing CITGO still has not implemented some of those measures.

 - Not installing additional wastewater storage capacity until December 2007 (still not adequate today) and not implementing flow reduction measures long after it became apparent through operating experience that the initial installed dedicated wastewater storage capacity of less than 20 MM gallons was not adequate. This was noted shortly after the system was commissioned in May 1994. The shortfall was well documented by engineering evaluations completed in 1997 and 1998. These shortfalls increased operating risks over time as the refinery was expanded, dry weather flow increased and waste oils and waste solids accumulated in the tanks.

- Lack of adequate numbers of treatment units for the May 1994 wastewater treatment system (API oil/solids separators; dissolved gas flotation (DGF) unit; wastewater cooling capacity; biological treatment clarification capacity). The lack of adequate treatment units contributed to LPDES permit effluent limit exceedances during periods when high rate wastewater flows were processed in the wastewater treatment system, including during the June 2006 spill event and during other periods when the wastewater treatment system was stressed. The lack of adequate numbers of treatment units heightened the need for additional wastewater storage capacity.
- Lack of effective construction oversight during installation of additional wastewater storage capacity (Tank 340) at and before the time of the June 2006 waste oil and untreated oily wastewater release. At the time of the release there were a number of breaches of the secondary containment dike.

16. My assessment of CITGO's avoided and delayed investment costs for wastewater storage capacity, wastewater pretreatment, wastewater treatment equipment and flow reduction measures, and avoided operation and maintenance costs that led to the June 2006 release is presented in Exhibit C.

17. Recommended Corrective Measures

In my opinion the following actions are needed to address the June 2006 release and to prevent future violations:

Wastewater Storage Capacity

- Within 6 months, complete with assistance from independent consultants an engineering study to evaluate possible dry weather and wet weather flow reduction measures, including additional separation of process wastewater and storm water, where feasible. Within 12 months, complete implementation of cost-effective dry weather and wet weather flow reduction measures.
- Within 6 months, complete with assistance from independent consultants reliable estimates of storm water generated from the 25-year/24-hour design storm. Submit estimates to EPA for review.
- Within 24 months, install supplemental wastewater storage capacity to contain in tanks the combination of process wastewaters and storm waters generated from the 25-year/24-hour design storm. Install corresponding supplemental secondary containment capacity.
- Within 24 months, complete tank integrity testing for Tanks T-310, T-320 and T-330 per API standards.
- Effective immediately and continuing thereafter, remove floating waste oil in Tanks T-320, T-330 and T-340 to minimum levels consistent with effective operation of oil removal and oil processing equipment.
- Effective within 12 months and continuing thereafter, achieve and maintain normal liquid levels of six feet or less in tanks T-320, T-330 and T-340 under non-storm conditions.

- Effective within 12 months, achieve and maintain minimum sludge (waste solids) levels in tanks T-320, T-330 and T-340 by more or less continually removing waste solids.

Wastewater Treatment

- Within 12 months complete engineering investigations of feasible COD reduction measures. Within 24 months complete cost effective COD reduction measures.
- Within 18 months, install two API oil/solids separators equivalent to existing API oil/solids separators as in-line operating units and spares. In addition, review and consider installation of oil/solids separation equipment upstream of the existing API oil/solids separators for scalping heavy oil/solids loadings. The installed capacity of oil/solids separators must be sufficient to process anticipated waste solids and waste oil loadings from the dry weather process wastewater flow, from storm flow and from the wastewater storage tanks.
- Within 18 months, install a third dissolved gas flotation (DGF) unit as an in-line operating unit and spare for supplemental oil/solid separation ahead of biological treatment.
- Within 12 months, ensure there is sufficient capacity in the Tetra residuals processing area to handle anticipated waste solids and waste oil loadings.
- Within 12 months, install fine bubble diffusers in aeration tank T-350.
- Ensure wastewater temperature entering the biological treatment system is within design standards by: (1) installing permanent additions to the wastewater treatment system cooling capacity; (2) annually, installing rental cooling tower units for wastewater treatment system during warm weather months; and/or (3) installing supplemental wastewater cooling capacity at the refinery operating units.

Indian Marais

- Within 3 months, submit to LDEQ and EPA for review and approval a quality assurance project plan for characterizing levels of toxic and hazardous substances associated with releases of CITGO's waste oils and untreated petroleum refinery wastewaters to the Indian Marais during the June 2006 event.
- Within 12 months after approval of the above-referenced study plan, complete implementation of the study. Within three months from completion of the study, submit a report of the study to LDEQ and EPA.
- Complete remediation of the Indian Marais in coordination with LDEQ and EPA based on the study results at a schedule to be determined.

D. Standards of Measurement

Section 311 of the Clean Water Act prohibits the discharge of oil to navigable waters and adjoining shorelines in harmful quantities.

In addition, CITGO's Louisiana Pollutant Discharge Elimination System (LPDES) permit; the federal Discharge of Oil and Oil Pollution Prevention regulations at 40 CFR Parts 110 and 112, respectively; the federal benzene NESHAPs regulation at 40 CFR Part 61, Subpart FF; and, certain implementing regulations of the Resource Recovery and Conservation Act (RCRA) are the principal regulatory standards against which CITGO's performance in this matter must be evaluated. CITGO's LPDES permits have been subject to public review and comment and have been accepted by CITGO. The underlying categorical effluent limitations guidelines regulation for petroleum refineries (40 CFR Part 419) used to derive the technology-based effluent limits in CITGO's LPDES permits was first promulgated by U.S. EPA in 1982 and last revised in 1985. The regulation was subject to public review and comment and is recognized and accepted as an established national standard. Likewise, the Discharge of Oil regulation, the Oil Pollution Prevention regulation, the benzene NESHAP regulation and the implementing regulations of RCRA have been promulgated by EPA and are recognized and accepted as established national standards.

The LPDES permit establishes definitive numerical monthly average and daily maximum effluent limits for discharges from specific outfalls that must be achieved at all times. The Discharge of Oil regulation at 40 CFR Part 110 prohibits discharges of oil in such quantities "as may be harmful" pursuant to Section 311(b)(3) of the Clean Water Act, as defined at 40 CFR§110.3.² The substantive requirement of the Oil Pollution Prevention regulation at 40 CFR Part 112 is that the owner or operator of a facility subject to the regulation must prepare and implement a Spill Prevention Control and Countermeasure (SPCC) Plan to prevent discharges of oil and to provide countermeasures for discovery, response and clean-up of oil discharges should they occur. The benzene NESHAPs regulation at 40 CFR Part 61, Subpart FF establishes substantive requirements to control and treat wastewaters that contain benzene at facilities that have wastewaters containing benzene above threshold levels prior to exposure of the wastewaters to the atmosphere. RCRA regulations at 40 CFR 268 prohibit the discharge of hazardous wastes to uncontrolled impoundments.

The SPCC Plan aspect of the Oil Pollution Prevention regulation at 40 CFR Part 112 is somewhat prescriptive in that SPCC Plans must be developed considering certain design standards (e.g., secondary containment standards). NPDES permits do not require installation of any particular technology or any particular control method to achieve and maintain compliance with the established NPDES permit effluent limits. NPDES permit holders are free to use any combination of in-process controls, pretreatment systems, end-of-pipe wastewater treatment systems or best management practices to comply. The underlying national categorical effluent limitations guidelines (ELGs) for petroleum refineries at 40 CFR Part 419 are based on certain model treatment technologies selected by EPA, including consideration of process area storm water; however, the ELG regulation does not require installation of any particular control technology, or attainment of any particular effluent flow rate or effluent concentrations for limited pollutants. Indeed, for complex point sources with multiple process wastewater and storm water waste streams such as the CITGO Lake Charles Manufacturing Complex, there are numerous engineering approaches and combinations of effluent flow and

² 40 CFR §110.3. Discharges of oil that (a) violate applicable water quality standards; or, (b) cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines.

pollutant concentrations that can be used to attain compliance with mass LPDES permit limits derived from 40 CFR Part 419 and the production measures set out in the regulation. The benzene NESHAP regulation specifies that waste management units be covered and emissions must be directed to control devices; however, owners or operators of facilities subject to the regulation have considerable flexibility to address compliance by treating individual waste streams or combined waste streams in a reasonable manner.

There are other state and federal environmental regulations that affect CITGO's management of process wastewaters, storm waters and residuals derived therefrom (e.g., other aspects of Louisiana and federal RCRA regulations; Louisiana air regulations; Louisiana groundwater regulations). However, the LPDES permit, the oil pollution prevention regulations, the benzene NESHAPs and certain aspects of the RCRA regulations were the primary drivers that affected the design and installation of the CITGO process and storm water management systems to replace the Primary Pond. These are the primary regulatory drivers that affect current operation of those systems.

Exercise of reasonable care in the design, construction and operation for CITGO's wastewater storage and wastewater treatment systems is important in this matter to assure protection of human health and the environment from releases of toxic and hazardous materials. I consider the following factors important to determine whether CITGO exercised reasonable care in the design, construction and operation of its wastewater storage and treatment systems:

- Adequate design of wastewater storage capacity and adequate design of the end-of-pipe wastewater treatment system based on the site-specific hydraulic and waste loading regimes selected as the basis for the design, including adequate contingency for operation and maintenance;
- Implementation of site-specific dry weather and wet weather flow reduction measures considered as part of the design of the wastewater storage facilities and end-of-pipe wastewater treatment system;
- Installation of site-specific wastewater pretreatment systems considered as part of the design of the wastewater treatment facilities;
- Proper sequencing of wastewater treatment units and proper design of individual wastewater treatment units in the end-of-pipe wastewater treatment system;
- Installation of adequate numbers of wastewater treatment units to account for the dry weather process wastewater flow, the design storm water flow and to account for necessary maintenance outages of critical equipment units;
- Proper operation and maintenance of installed wastewater storage facilities and the end-of-pipe wastewater treatment system in accord with established standard operating procedures; and,
- Effective and timely response to any shortfalls noted in the initial installation after a reasonable amount of time of actual operating experience.

Exercise of reasonable care is particularly important in this matter because the untreated oily wastewaters that CITGO generates at the Lake Charles Manufacturing Complex contain waste oils; many designated toxic pollutants under the Clean Water Act; hazardous substances; and, materials (waste oil, waste solids) that are classified as listed hazardous wastes (F037) under RCRA when settled from the wastewaters. Furthermore, benzene-containing wastewaters generated by CITGO are classified as characteristic hazardous wastes (D018) until the benzene is removed. Consequently, any release of waste oil and untreated oily wastewaters generated by CITGO constitutes a release of toxic pollutants and hazardous wastes to the environment.

E. CITGO's Design and Operation of Wastewater Storage and Wastewater Treatment Systems

1. CITGO Wastewater Management and Wastewater Treatment Design Prior to May 1994

From the 1970's up to May 1994 CITGO discharged refinery process wastewaters and storm water collected from approximately 660 acres of the site to a 27-acre impoundment called the Primary Pond (aka "surge pond") (CIT0284935-36).^{3, 4} The Primary Pond was equipped with an oil skimmer. The Pond effluent was pumped to downstream units for additional treatment prior to discharge to the Indian Marais through Outfall 003A. Treatment units following the Primary Pond included an equalization pond, API oil/solids separation, dissolved air flotation, aeration basins (biological treatment), clarifiers, a settling basin and a polishing pond (CIT0284936, CIT0258618, see schematic diagram included as Exhibit D). Overflows of untreated or partially treated refinery wastewaters from the Primary Pond were discharged directly to the Calcasieu River through Outfall 003B. CITGO elected to cease discharging untreated petroleum refinery wastewaters to the Primary Pond as a means to comply with minimum technology standards for surface impoundments under the 1984 Hazardous and Solid Waste Amendments to RCRA and benzene NESHAPs. After May 1994 CITGO collected and treated wastewaters from the Lake Charles Manufacturing Complex in newly constructed wastewater storage and treatment systems.

Prior to May 1994, CITGO reported a number of overflows and discharges of untreated or partially treated wastewaters from the Primary Pond. For example, an overflow of the surge pond was noted by CITGO in January 1987 after a "... very rainy December" (CIT0427254). The CITGO Board of Directors was informed during July 1989 that heavy rains in May and June 1989 had caused the surge pond to overflow to the Calcasieu River. It was reported that to avoid future overflows, the refinery would have to dredge the surge pond to expand capacity and segregate the sewer system from the West Tank Farm (CIT0333159). Overflows and discharges from the Primary Pond during wet weather conditions are significant because of the volume of wastewater surge capacity available in the Pond. Those occurrences were indicative of the large volumes of storm water that were then collected and mixed with untreated refinery process wastewaters prior to end-of-pipe treatment and were relevant for the design of the new wastewater storage and treatment systems.

Following is a summary of engineering studies and field surveys CITGO conducted to address closure of the Primary Pond and construction of new storm water management facilities and a new wastewater treatment system for treatment of site process wastewater and site storm water that were put on line during May 1994.

³ Badger Design & Constructors, Inc., reported storm water runoff from the entire refinery, with the exception of the West Tank Farm and part of the administrative area was directed to the primary settling pond. *CITGO FIELD STUDY, BD1333* (CIT0284958).

⁴ The total capacity of the Primary Pond was reported as over 1,000,000 cubic yards, with 600,000 cubic yards of sludge accumulated as of 1984 (CIT0427194). Thus, 60% of the capacity of the Pond was filled with waste solids (sludge). 1,000,000 cubic yards is equivalent to approximately 202,000,000 gallons. Available Primary Pond (surge basin) capacity for refinery wastewaters as of 1984 was thus approximately 80,000,000 gallons. ES reported in 1987 the estimated usable storage volume was 50,000,000 to 60,000,000 million gallons.

Engineering-Science, Inc. (1987)

CITGO retained Engineering-Science, Inc. (ES) of Austin, TX to conduct studies of the process wastewater and storm water collection and management systems at the Lake Charles Manufacturing Complex in light of the pending closure or upgrade of the Primary Pond (CIT0258608-694). ES reported the Primary Pond was classified as a hazardous waste impoundment under the Hazardous and Solid Waste Amendments (HWSA) of 1984 because process wastewaters that contained benzene were discharged to the Pond. ES reported that prior to 1974 API separator effluent containing benzene was discharged to the Pond and that pond sediments were contaminated with benzene (CIT0427194). ES also reported that as of November 1987 the estimated usable storage volume of the Pond was 50 to 60 million gallons (CIT0258620).

ES issued its report in November 1987 and recommended that CITGO provide additional storm water surge capacity considering that the surge pond would be closed in place (CIT0258615). In addition to a number of recommended process wastewater and storm water collection system improvements, ES recommended that CITGO divert certain clean storm water streams for direct discharge to the Indian Marais and the Calcasieu River and install three (3), 300,000-barrel steel tanks to provide storm water surge volume.⁵ That design was based on a 10-year/24-hour storm event with a rainfall intensity of 8.5 inches and recommended total storm water surge capacity of approximately 37,800,000 gallons for three (3) tanks (CIT0178334).

As part of its analysis, ES estimated the maximum base case required storm water surge volume was 47,000,000 gallons, which corresponded to 12.7 inches of rain over seven (7) days (CIT0258665, -668, -669). This volume is equivalent to nearly four (4), 300,000-barrel steel tanks. In a document titled "Primary Pond Study" (CIT0427194-209) that was apparently prepared by CITGO within the same timeframe as the 1987 ES report, CITGO also noted the volume of required storm surge capacity was 47,000,000 gallons (CIT0427198, 209). ES recommended three (3) 300,000-barrel storm water surge tanks (37,800,000 gallons) under the assumption that certain uncontaminated storm flows would be diverted for direct discharge.

Badger Design & Constructors, Inc. and Badger Engineers (1991 – 1993)

CITGO retained Badger Design & Constructors, Inc. (BDC) of Tampa, FL during the period of at least 1991 to 1993 to perform a number of engineering studies and field surveys that were focused on developing storm flow estimates and design parameters for a new process wastewater and storm water treatment system. BDC issued report no. BD1333 of its planned field studies that included the following elements (CIT0284950-97):

- New hydrologic analysis for the then existing CITGO storm water collection system. It was determined that pertinent information from the previous ES hydrologic study was not available and a new study to replace the prior study would be conducted;
- Flow reduction: use of abandoned deep wells for disposal of sour water stripper bottoms; direct discharge of storm water from the Clifton Ridge area; direct discharge of controlled cooling tower blowdowns; filter backwash modifications; direct discharge of neutralized cation and zeolite backwashes; verify disposition of boiler blowdowns from a number of sources; wastewater management for the delayed coke units; dock area study;
- COD reduction;
- Process study of caustic neutralization plant;
- Hydraulic capacity of secondary clarifiers;

⁵ One barrel is equivalent to 42 gallons. The capacity of each 300,000-barrel steel tank would be 12,600,000 gallons.

- Solvent extraction for wastewater streams originating in Thermal Area (high COD and benzene loadings); and,
- Industry survey to assess how other refineries manage wastewaters and address compliance with recent regulatory changes.

At or about the same time, Badger Engineers, Inc. (Cambridge, MA) was retained by CITGO to prepare an *Environmental Management Program* to address the following:

- Assess existing refinery conditions with respect to refinery operations, storm water handling, air emissions, solid waste handling and wastewater treatment;
- Review planned refinery expansion and environmental projects; and,
- Develop an environmental management plan.

Badger Engineers issued a draft project report in August 1991 under Badger Job No. E-9021 (CIT0456968-7157). The major planned environmental projects reviewed included storm water management, sour water stripping and benzene NESHAPs compliance. These projects were evaluated under two cases: with and without refinery expansions planned through 1995. The report included recommendations for a comprehensive environmental wastewater management plan with the following key features (CIT0457132-33):

- Segregate refinery sewer system such that the Panama Canal and Cit-Con ditches become low oil, low total dissolved solids (TDS) sewers and the API sewer becomes a high oil, high TDS sewer;
- Low oil, low TDS operating area wastewater streams are diverted to the Panama Canal rather than discharged to the API sewer or hard-piped for collection;
- The wastewater flows from the outlet of the Panama Canal are collected, treated to remove oil and suspended solids, and reused;
- A clarifier is installed to remove suspended solids from incoming Sabine River water;
- Storm water is diverted for direct discharge from the Intermediate Tank Farm and the South Tank Farm in addition to storm water diverted from the West Tank Farm and the administration area;
- Sour water injection wells are closed; sour water strippers are installed and the stripper bottoms are collected for reuse;
- Wastewater streams containing benzene are segregated and treated in a NESHAP-benzene stripper; the stripper bottoms are sent to secondary wastewater treatment (see *discussion below*);
- Cooling towers are all converted to non-chromate treatment programs, make-up water rates are controlled, uncontrolled blowdowns are eliminated, and cooling tower performance is optimized; and,
- Future water streams received from the Cit-Con Plant are collected for reuse in the CITGO refinery.

As part of its review, Badger Engineers considered two principal options for benzene NESHAPs compliance:

- (1) a new hard pipe collection system for wastewater streams subject to the benzene NESHAPs followed by a steam stripper; or,

- (2) Seal the existing sewer system and install a closed end-of-the-pipe treatment system.

Badger Engineers recommended the first option, which would involve collection and steam stripping approximately 695 gpm of benzene containing wastewaters (CIT0457119). Badger Engineers also reported that, after preliminary studies, it was determined the second option was impractical for a number of reasons including process safety and cost (CIT0457114-5).

In December 1993 Badger Design & Constructors (BDC) issued a design basis memorandum (CIT0088507-724) for storm water management and process wastewater/storm water treatment at the Lake Charles Manufacturing Complex with the principal hydraulic design parameters listed in Table 1.

Table 1
CITGO Petroleum Lake Charles Manufacturing Complex
Principal Hydraulic Design Parameters
Storm Water Management and Process Wastewater/Storm Water Treatment
Badger Design & Constructors (December 1993)

Item	Design Basis
Storm event ⁶	25 year-24 hour storm 10.25 inches/24 hours 5 inches/1 hour
Drainage area	117.86 acres
Dry weather process wastewater flow	5,430 gpm
Peak storm event flow (process wastewater & storm water)	152,000 gpm
Storm water surge volume	20,400,000 gallons

The BDC December 1993 Design Basis Memorandum at Figure 3-2 shows the drainage areas from West Tank Farm, South Tank Farm, Intermediate Tank Farm and Administration area were not included in the design (CIT0090871). BDC based the hydraulic design on the basis that these areas would not drain to the wastewater treatment plant (CIT0090874), but the Intermediate Tank Farm still does. ENSR reported in 1998 the total refinery area was 856 acres (CIT0088845). ES reported in 1987 the area draining to the then existing storm water collection system and the surge pond was 660 acres (CIT0258620). Thus, it appears the BDC design basis for storm water collection (117.86 acres) included less than 18% of the area that may have drained previously to the Primary Pond (surge pond).

BDC originally estimated the design average dry weather process wastewater flow rate at 6,480 gpm. BDC reported a revised design average dry weather process wastewater flow of 5,430 gpm based on the following: (1) diversion of boiler blowdown (50 gpm) and Clifton Ridge flow (400 gpm) to direct discharge; (2) optimization of filter operations (250 gpm); and, (3) reduction in design contingency (350 gpm) for cost reduction (CIT0090869). This amounts to a reduction of 1,050 gpm, or approximately 16% of the initial design average dry weather flow set out by BDC.

⁶ In addition to the 25 year-24 hour design storm event of 10.25 inches reported by BDC, a design one-hour storm event of 5 inches in one hour was reported (CIT0178351, CIT0311992).

Design parameters for individual components of the process wastewater/storm water collection system and the wastewater treatment system reported by BDC are shown in Table 2. The wastewater treatment (WWT) system that included the new and existing wastewater storage and treatment units listed in Table 2 was placed in operation during May 1994 (CIT0258843) Exhibit E is a schematic diagram of that system (CIT0339990).

Table 2
CITGO Petroleum Lake Charles Manufacturing Complex
Major Tankage and Equipment Design Specifications
Storm Water and Process Wastewater/Storm Water Treatment
Badger Design & Constructors (December 1993)

Item	Design Basis															
Panama Canal lift station, L-102 A/B	124,000 gpm															
Oily water lift station, L-100 A/B	28,000 gpm															
Storm water surge tanks Floating roof w/oil skimmers & eductors for solids management [two (2) – new] T-320, T-330	210’ diameter, 50’ high Working volume: ~ 10,100,000 gal each ~ 20,200,000 gal total Normal pre-storm operating level 5.5 feet															
API separators [four (4) - new, above ground, 4-channel] L-201, L-202, L-203, L-204	<table><tr><td><u>Unit</u></td><td><u>Total</u></td><td></td></tr><tr><td>1,750</td><td>7,500 gpm</td><td>average design flow</td></tr><tr><td>2,500</td><td>10,000 gpm</td><td>max hydraulic flow</td></tr></table>	<u>Unit</u>	<u>Total</u>		1,750	7,500 gpm	average design flow	2,500	10,000 gpm	max hydraulic flow						
<u>Unit</u>	<u>Total</u>															
1,750	7,500 gpm	average design flow														
2,500	10,000 gpm	max hydraulic flow														
Dissolved air flotation (DAF) [two (2) - new] L-223, L-224	<table><tr><td><u>Unit</u></td><td><u>Total</u></td><td></td></tr><tr><td>5,000</td><td>10,000 gpm</td><td>average design flow</td></tr></table>	<u>Unit</u>	<u>Total</u>		5,000	10,000 gpm	average design flow									
<u>Unit</u>	<u>Total</u>															
5,000	10,000 gpm	average design flow														
Evaporative cooler [one (1) – new] CT-250 A/B	5,500 gpm @ 127°F to 95°F 87 x 10 ⁶ BTU/hr 7,500 gpm max hydraulic capacity															
Equalization tank [one (1) – new] T-310	210’ diameter, 50’ high; ~ 10,000,000 gallons Average flow rate 5,430 gpm Normal operating level 31 feet Maximum operating level 45 feet															
Extended aeration activated sludge tanks [three (3) – new] T-350, T-360, T-370	145’ diameter; ~ 3,400,000 gallons each 31-hour retention @5,500 gpm 17-hour retention @10,000 gpm															
Clarification [two (2) – existing] L-1, L-2	Original design – 345 gpd/ft ² (avg. design flow) <table><tr><td><u>Unit</u></td><td><u>Total</u></td><td></td></tr><tr><td>2,715</td><td>5,460 gpm</td><td>average design flow</td></tr><tr><td>5,000</td><td>10,000 gpm</td><td>max hydraulic flow</td></tr></table> Reported max flow for “good” performance <table><tr><td><u>Unit</u></td><td><u>Total</u></td><td></td></tr><tr><td>3,100</td><td>6,200 gpm</td><td>400 gpd/ft²</td></tr></table> (CIT0065173)	<u>Unit</u>	<u>Total</u>		2,715	5,460 gpm	average design flow	5,000	10,000 gpm	max hydraulic flow	<u>Unit</u>	<u>Total</u>		3,100	6,200 gpm	400 gpd/ft ²
<u>Unit</u>	<u>Total</u>															
2,715	5,460 gpm	average design flow														
5,000	10,000 gpm	max hydraulic flow														
<u>Unit</u>	<u>Total</u>															
3,100	6,200 gpm	400 gpd/ft ²														
Final effluent settling pond [one (1) – existing]	270’ x 150’ x 10’ deep (3.0 MM gal, nominal capacity) (CIT0192177)															
Final effluent polishing pond [one (1) – existing]	620’ x 250’ x 6’ deep (8.4 MM gal, nominal capacity) (CIT0192177) (6.96 MM gal calculated volume)															

⁷ The design working volume of 10,100,000 gallons for each storm water surge tank implies a high liquid level (HLL) of 44.5 feet with the stated normal pre-storm operating level of 5.5 feet. However, the tanks have overflow structures at 43 feet, making the maximum capacity at overflow approximately 9.7 MM gallons for each tank (19.4 MM gallons total) if the normal pre-storm operating level is 5.5 feet. Each foot of tank depth is equivalent to approximately 259,100 gallons or 6,169 barrels. ENSR reported then existing (January 1998) design storm water storage capacity in Tanks 320 and 330 at 9,200,000 gallons each (18,400,000 gallons total) with a lower operating level of 5.5 feet and a high operating level of 41 feet (CIT0088861). A similar design storm water storage volume (18,800,000 gallons) is reported in a CITGO summary of the process design basis for the WWT system upgrade (CIT0178351).

CITGO Cost Reduction Measures

As described below, during the design phase of the new wastewater storage and wastewater treatment systems in late summer 1992, CITGO management put a hold on the projects to allow for supplemental hydrology studies and wastewater sampling studies for purposes of redefining project scope and determining possible project cost reductions.

CITGO documents reveal that the company eliminated or deferred the equipment items listed in Table 3 from the wastewater treatment system design prior to preparation of BDC's December 1993 design basis memorandum (CIT0098336-350; CIT0178334).

Table 3
CITGO Petroleum Lake Charles Manufacturing Complex
Wastewater Equipment Eliminated for Cost Reduction
Wastewater Collection and Treatment Systems
March 1994 (CIT0098350)

Equipment Item	Investment Cost (Order-of-magnitude (\pm 25%) estimates of TIC costs)
One Panama Canal storm water pump	\$600,000
Two API separators	\$9,900,000
One primary DAF	\$4,500,000
One storm water tank	\$12,000,000
One aeration tank	\$4,100,000
Caustic neutralization unit	\$2,700,000
One slop oil return tank	\$1,500,000
Total	\$35,300,000

A CITGO interoffice letter titled "*Chronology History of Wastewater Treatment Plant Upgrade Project and Benzene NESHAP Project*" (February 18, 1994) states as follows for entries for August 1992 and July 1993:

August 5, 1992

"Project Team presents the overall project concept and cost to CITGO Management. The cost breakdown is as follows:

BE&C	\$ 84 MM
Jacobs	\$ 21 MM
Project Mgmt Cost	\$ 10 MM
Other	\$ 5 MM
Contingency	\$ 30 MM
TOTAL	\$150 MM

CITGO Management directed the project team to continue cost reduction measures. CITGO decides to request an extension for the required compliance date. Plans are put in place to do significant in-plant sampling and hydrogeology studies with the intent of lowering project costs and verifying design basis." (CIT0178333-334)

August 5 through September 28, 1992

"At this time CITGO Management directs that all project work (Wastewater and NESHAP) be put "on hold". No project work is to proceed until the detailed hydrology studies

(including segregated areas of “first flush” and entire Refinery first flush) and wastewater sampling studies have been completed.” (CIT0178334)

August 1992

“BE&C and the Project Team concentrate on evaluation of scope reduction and cost reduction studies as agreed to by CITGO Management.

CITGO directs biotreatment design to comply with 90% non-exceedance for COD in order to reduce capital costs. The new design provides 99% non-exceedance for phenol.

Based on CITGO’s analysis of the chronological COD loadings, most of the loadings higher than the 90% non-exceedance level for years 1990, and 1991, can be directly attributed to Refinery unit turnarounds or process upsets. CITGO Management has agreed to initiate a management plan to minimize contaminants routed to the sewer during turnarounds, routine maintenance, and routine operations. This culture change will allow the biological system to include three (3) aeration tanks instead of the four (4) previously designed.

The Project Team initiates a “modular” approach to the equipment design and layout of the project. This approach means that the size and number of pieces of equipment (including spares) for each system was set by the design basis. Incremental capacity and efficiencies for each system will be handled by adding additional “modules” (pieces of equipment) in the future as needs justify. Therefore, plot space has been reserved for the following pieces of potential future equipment:

- *One Panama Canal stormwater pump*
- *Two API separators*
- *One primary DAF*
- *One stormwater tank*
- *One aeration tank*
- *One slop oil return tank” (CIT0178334)*

July 1993

“The Caustic Neutralization Unit is cancelled due to inability to estimate a quantifiable justification and as a cost savings measure. The spent caustic will be routed to the dry weather flow line and neutralized in the pH control system.” (CIT0178338)

Although the above notes indicate the CITGO Project Team initiated a “modular approach” to the design with the plan to add additional equipment as future needs might justify, the initial installation was cut to below the bare minimum and the modular approach was not followed subsequently.

During the design process for the new WWT system, BDC provided to CITGO during February 1992 a number of items for potential cost savings (CIT0267464-474):

- *Storm Water Pumping Rate:*

Segregate areas with minimum contamination such as the roads and areas between the processing areas. This would reduce by one half the total area contributing storm water to the main sumps and also reduce the hydraulic load on the bio-treatment system.

Allow limited flooding in the processing areas during peak rains.

- *Reduce the Storm Water/Equalization Tank Capacity:*

Using classical calculation methods Badger determined a surge capacity requirement of 34 million gallons for the 25 year storm intensity. This surge volume was proposed in the early design. Citgo requested another 10 million gallons above that calculated minimum to handle potential tank outages. Badger recommends that the additional surge capacity be deleted. If Citgo will assume the limited risk in downsizing the surge capacity, significant money could be saved.

- *Reduce the Size of the Biotreatment System*

Badger has already shown that by reducing the phenol design basis from 40 to 30 ppm at the inlet, the aeration tank sizing can be reduced from 200 ft. to 160 ft in diameter. This savings compounds significantly to yield a \$2.2 million dollar cost reduction. Thorough scrutiny of the potential phenol sources may allow a phenol design basis between 10 and 20 ppm, yielding additional significant savings.

At present, the biotreatment system is sized such that one aeration system could handle the throughput from the entire plant. Badger's past experience has shown that full outage of an aeration system is extremely rare. A less conservative basis with respect to the design of this system will allow major savings.

Excerpts from page 3-2 the BDC Design Basis Memorandum are presented below:

"In September 1991 the Replace Wastewater Impoundments Project began (Badger Project BD-1331) as an initial process design phase of the current Wastewater Treatment Plant Upgrade Project. The basis for the BD-1331 design were the flows and destinations in Figure VIII-5 of the E-9021 Report (expansion system). In March 1992 CITGO decided that it would be preferable to eliminate the dedicated benzene NESHAP stripper system in favor of comingling the NESHAP wastewater with the main wastewater stream in a single vapor controlled treatment system. In addition, CITGO revised the estimate of wastewater generated from future or expanded refinery units from the flows assumed for the E-9021 report. ...

In August 1992, a capital cost estimate was made for the overall project and this cost became an overriding issue for CITGO. Reducing wastewater flow to the treatment plant was examined as one potential way to lower the project cost. Several streams shown going to the WWTP were identified by CITGO as candidates for removal from the WWTP, either through alternative treatment or disposal or by direct discharge. A new project (Badger Project Number BD-1333) was started in August 1992 and executed in parallel with Badger Project BD-1332. The objective of BD-1333 was to sample and analyze wastewater streams and to determine whether alternative treatment or disposal is possible. The complete scope of the BD-1333 Project, including all of the candidate streams, can be found by referring to the report, Field Survey/Cost Reduction Studies, October 26, 1992, Badger Project Number BD-1333."

The above information indicates CITGO decided as of March 1992 to address compliance with the wastewater aspects of the benzene NESHAPs (40 CFR Part 61, Subpart FF) by controlling benzene emissions from wastewaters in a combined system whereby benzene-containing and non benzene-containing wastewaters would be co-mingled (mixed) and vapor-controlled from the collection system through part of the wastewater treatment system (see also CIT0178331, entry for February 28, 1992). That approach was ultimately implemented when the wastewater collection system was upgraded and the new treatment system was installed in 1994. This decision was opposite the recommendation of Badger Engineers for a separate hard-piped benzene wastewater collection and control system (CIT0457114-5).

CITGO commissioned NOVA Engineering, Inc. (NOVA), to perform an independent third-party review of BDC's conceptual design for the wastewater storage and wastewater treatment systems. NOVA provided a report of its review to CITGO on July 21, 1992 (CIT0285167-174). Selected parts of the NOVA report are presented below:

- It is NOVA's intent in this section to identify areas of potential improvement and upgrading as the title "Limitations and System Sensitivity" would suggest. We have noted several areas outside our comfort zone, and although they do not reflect our belief that the facility will not work, they do identify areas that should be given further consideration by CITGO. Furthermore, while NOVA Engineering, Inc. may agree in "concept" with some of the decisions made on this project, that conceptual agreement does not automatically translate to our blanket endorsement of "detailed decisions" which have yet to be made.
- The wastewater impoundment replacement project consists of several distinct processes each of which are required to meet the NPDES requirements. These distinct processes are interrelated and interdependent and have operating sensitivities which are different than the present secondary wastewater treatment facility which uses two large impoundments, the surge pond and the equalization basin. The new facility will no longer have the advantage of these large impoundments, and it is important to recognize and anticipate the future regulatory requirements so that a successful treating program can be implemented.
- Process Wastewater and Storm Water Diversion Box. There will be circumstances which will cause upsets in the new facility which would have been previously handled through the large impoundments. ... Pumping, no matter how gentle, creates additional hydrocarbon loading to the wastewater treatment equipment. ... Therefore, a pumped system is expected to impart to the secondary wastewater treatment system: more solids, more COD, more hydrocarbon, more emulsions, more VOC, more hazardous waste, more waste recycling, more waste handling. ... In addition, the impact of removing the large volume of holding capacity in the existing settling pond with tankage has not been evaluated. We recommend further evaluation of this item and possibly the provision for additional tank storage capacity if needed.
- Primary Oil Water & Solids Separation. Pumping fluids from the diversion box to the primary oil, water and solids separation may create emulsions and sludge loadings which are not experienced in the existing secondary wastewater treatment system. The result of these increased contaminant loadings is the creation of more skimmings and settlement in the oil, water and solids separator. It is also likely that the discharge from the primary separator will also contain increased hydrocarbons and solids loadings. This means the DGF (Dissolved Gas Flocculation (Flotation) System) must effectively remove free and dispersed oil in order to protect the ASU from excessive hydrocarbon in the feed. ... Maintenance of the new primary oil, water and solids separator will require extra standby capacity. When the equipment is down for maintenance, there are no auxiliary impoundments to equalize the flow. The new separator must perform to design at all times. ... Upsets in the operating units will carry over into the primary separator operations. ... The volume reduction in the new primary separator compared to the surge pond is tremendous. The impact of upsets are likely to be more severe in the new treatment system. Extra care must be taken in the operating units to prevent upsets and spills. ... When the treating equipment operates on the edge of performance with little surge capacity, this may lead to occasions when the equipment is out of performance. When the oily water separator is out of performance, the contaminant load is transferred to the downstream equipment and the potential for slippage or sloughage is increased. Efforts must be made to keep all equipment in good operating order and not to push the system beyond its design capability. ... Management must install an urgency in the operating unit(s) to minimize dumping to the wastewater system. Alternatives to wholesale dumping must be investigated.

- Dissolved Gas Flotation System. The dissolved gas flotation system is (the) last opportunity to remove emulsified hydrocarbon in the process wastewater stream prior to equalization and biological oxidation. The hydrocarbon and emulsion load as well as oily solids load is likely to increase in the new treatment system. ... Solids removal is also important in preventing hazardous waste components from entering the biological treatment system. DGF settled solids are often oily or could contain toxic materials which are lethal to the biological population in the ASU. ... Contrary to the present DAF operations, the DAF operations will require close operator attention and must be kept in good working order.
- Equalization and Surge Storage Tanks. The equalization and surge storage tanks are very large tanks with internal floating roofs. Maintenance of these large tanks for removal of settled hazardous solids will be difficult. ... The long and frequent cleanouts will have to be carefully timed so that storm water surge capacity can be preserved. ... The surge tanks are not equipped with mixing devices to ensure equalization prior to reprocessing. Solids will tend to accumulate in these tanks and the tank floor will become stagnant. As a result, the storm water when contaminated with process wastes will be variable in contaminant loading.
- Activated Sludge Treatment Unit. The activated sludge unit is the heart of the secondary wastewater treatment facility. Control of a viable biological population is required. The new treatment system is replete with potential frustrations to control: short hydraulic detention times, sensitivity to surges, sensitivity to fluctuations in nutrient content, sensitivity to fluctuations in toxic component composition and quality, and others. Controls must be in place to mitigate against prolonged upsets to the ASU. ... There are no provisions to contain or rework off specification wastewater. ... The proposed biological treatment unit is designed for a 99% non-exceedance level for COD. This presupposes that the COD entering the ASU is biodegradable by the biological organisms in the ASU at the designed detention time and is not refractory. No testing was performed to confirm this possibility.
- Secondary Clarifier System. The secondary clarifier system is the "pinch point" or bottleneck in the secondary wastewater treating facilities. The settling capacity of the existing clarifiers require many process variables to be optimized: sludge settling index, dissolved oxygen content, flow rate, MLSS content, flocculant rate, biomass viability, inert solids content, etc. The consequence of operating at the proposed elevated design rates is the carryover of activated sludge into the settling and polishing ponds.

In addition, CITGO received another review of the design specifications for the biological treatment system clarifiers by Earnest F. Gloyna, a consulting engineer from Austin, TX (CIT0262580-83). Mr. Gloyna cited capacity constraints in the two existing clarifiers and concluded that CITGO should consider a third 135 ft diameter clarifier to allow processing 10,000 gpm of wastewater.

CITGO considered the NOVA report and may have added eductors in the wastewater storage tanks to assist in removing solids as a result of the NOVA recommendations, but other than that apparently did not modify the preliminary BDC design in any appreciable manner. As described below, CITGO rather made substantial cuts in the BDC design for cost savings, including deleting wastewater storage and wastewater treatment capacity and reducing the design criteria for COD loading. Note at the time of the NOVA review, the preliminary design wastewater storage capacity was reported at 41 MM gallons comprising one wastewater equalization tank; one equalization/surge tank and two surge tanks (CIT0262433, 482). Only the equalization tank and equalization/surge tank were to be equipped with eductors for solids mixing (CIT0262483). A CITGO Interoffice Letter dated August 20, 1992 presents a summary of a meeting held with CITGO Lake Charles and Tulsa management to review the scope and cost estimate for the

project to replace the wastewater impoundment (CIT0225450-477). The document reports the main directions received by the project team from the meeting were:

1. *The design of the unit must have the ability to consistently treat dry weather flow to permitted contaminant levels. The basis of the design of the Wastewater Treatment Facilities will now be focused on reducing the dry weather flow rate to a practical minimum through water reuse and, where applicable, direct discharge or elimination. The design basis for the contaminant levels of the influent wastewater will be based on reduced COD loadings as compared to 99% non-exceedance historical levels. The design will now reflect minimum impact on contaminant levels from Refinery turnarounds, unit upsets, and gross hydrocarbon dumping to the sewer*
2. *The design of the storm water handling system should provide the absolute minimum facilities required to handle a 25 year storm event. Opportunities for "first flush" design will be examined throughout the Refinery. Studies will be made on specific units as well as the overall Refinery.*

As part of its design review process CITGO considered more than twenty possible cost reduction measures. The following high risk cost reduction measures were ultimately required by CITGO as part of the final BDC design, despite CITGO's own assessment of risk (CIT0225459-60):

Table 4
CITGO Petroleum Lake Charles Manufacturing Complex
Wastewater Storage and Wastewater Treatment Systems
CITGO Cost Reduction Measures and Risk Assessment

No.	Cost Reduction Measure	CITGO Risk Assessment
6	Reconfirm drainage areas for rainfall calculations	Doesn't account for future units. Could lead to under designed storm handling system
7	Reduce size of storm tanks to meet actual surge volume	No safety factor in containing a 25 year rainfall event; actual volumes generated may exceed design calculations
9	Reduce dry weather flow by 2,545 gpm to 3,955 gpm	High risk; will require testing; discharge must meet NPDES permit limits; flow spikes must be handled in storm tanks.
10	Use 90% nonexceedance in lieu of 99% nonexceedance for COD load	High risk; will require testing; discharge must meet NPDES permit limits; no contingency, operating practices must change
11	Eliminate one bay at the API separator	No spare oil/solids removal capacity; high risk when separator in on T/A; cannot handle wet weather flow
12	Eliminate one 60' DAF unit	No spare oil/solids removal capacity; high risk when DAF is on T/A; cannot handle wet weather flow
27	Eliminate spare equipment	No allowance for equipment failure in a system that has to operate to be legal

Aside from Item No. 9 in Table 4, where CITGO reduced dry weather flow by a lesser amount, in part by eliminating contingency, CITGO implemented each the above cost reduction measures. I agree with each of CITGO's risk assessments cited above. As described throughout this report, every one of the negative aspects cited in the above risk assessments occurred after the wastewater storage and treatment facilities were put on line in May 1994, some soon after. The last item in Table 4 is telling in that it captures CITGO's reckless disregard for reasonable standards of care with respect to the design of its wastewater storage and treatment facilities. Based on the record in this matter, CITGO knew or should have known it needed additional wastewater storage and wastewater treatment capacity but chose not to install it.

Exhibit F presents a review of CITGO's engineering design for the API oil/solids separators, the dissolved gas flotation (DGF) units, the biological treatment aeration tanks and the biological treatment system clarifiers. Except for the two existing biological treatment system clarifiers, which were undersized for the stated maximum hydraulic flow of 10,000 gpm, overall the design parameters used by BDC are within reasonable ranges reported for petroleum refinery wastewater treatment units and similar biological treatment systems at the stated hydraulic and waste loadings. The major shortfalls with the overall wastewater treatment system design have less to do with the design parameters selected to size individual treatment units and more to do with the number of individual wastewater storage and treatment units constructed. In other words, the treatment system was undersized. Also, the decision to reduce the COD design from the 99th percentile non-exceedance level to the 90th percentile non-exceedance level, coupled with the apparent initial underestimation of the untreated wastewater COD loading contributed to underperformance, particularly when the system was operated under high flow conditions and under stress.

2. Operation of Wastewater Storage and Wastewater Treatment Systems

Shortly after the new wastewater storage and treatment systems were put on line, CITGO wastewater treatment system operators noted shortfalls in the installed storm water surge capacity. Operators noted that during a storm event on August 23, 1994 (3.8 inches of rain in 45 minutes) approximately 10.1 million gallons of storm surge capacity out of an ideal available design volume of 22.5 million gallons was filled. Based on this experience CITGO wastewater treatment personnel inferred that approximately 27 million gallons of storm surge capacity may have been required to contain the design 25 year, 24-hour storm event (CIT01955840-841). This was more volume than was available. CITGO personnel also stated on October 27, 1995: *"The potential for an overflow situation well short of the 25 year event is high and an overflow policy acceptable to all parties is needed to ensure that proper actions are taken before another event occurs."* (CIT0097973). CITGO personnel noted several diversions of storm water to the refinery surge pond during large storm events in a CITGO Request for Design Change Authorization document dated October 31, 1996 (CIT0201026). A third storm water tank was recommended at the time. The diversions to the surge pond were in lieu of overflowing the wastewater storage tanks. A CITGO internal presentation from October 1996 noted that an event analysis reconfirmed there was no "Fat" in the design; there was no capacity to "Walk Up" flow; practical capability cited as 6" to 8" of rainfall instead of 8" to 10" of rainfall under ideal conditions; Outfall 003 exceedances were likely with diversion (CIT0227558).

In January 1997 CITGO developed a screening and evaluation study titled "Stormwater Capacity @ WWTP Study", DCA NUMBER 96-1139 (CIT0064566-573). Sections 1.1 (Current Situation) and 1.2 (Statement of the Problem) are presented below:

1.1 Current Situation

The stormwater storage capacity was designed to handle a 25-year, 24-hour storm of 10.25 inches or one hour storm of 5.25 inches. The hydraulic design capacity was based on several assumptions which include

- 1) *The stormwater tank level would be 4'-0" when a rain event begins.*
- 2) *The dry weather flow rate would be at or below 5,500 gpm to facilitate design draw down rate.*
- 3) *The flow rate through the aeration system would be immediately increased to 10,000 gpm at the start of the event.*
- 4) *All areas defined for direct discharge would be in operation.*

2.2 Statement of the Problem

Since the startup of the new facility, there have been several near-miss events in terms of exceeding the capacity of the stormwater tanks and four events when diversion of stormwater to the Surge Pond was necessary. None of the events were close to a 24 (sic 25) year rainfall event. Additionally, the tanks have a build-up of sludge and an oily rag layer resulting in the tank operating level to be approximately 8'-0" instead of 4'-0".

ENSR Studies (1997 – 1998)

CITGO contracted with ENSR to perform a source control identification study and a storm water screening and evaluation study.

Source Control Identification and Information Survey

ENSR issued a draft report in June 1997 titled "Source Control Identification and Information Survey", ENSR Document Number 1515-030-300 (CIT0116886-0117137). ENSR issued a final report with the same title in October 1997, ENSR Document Control Number 1515-030-300-2 (CIT0200034-0200296).

ENSR noted in Section 1.0 (Introduction) of its final October 1997 Source Control report that the new biotreatment system was designed for an average chemical oxygen demand (COD) loading of 48,900 lbs/day and a maximum COD load of 70,300 lbs/day. ENSR reported the design COD loads were premised on implementing several COD and flow reduction measures including: recycle sour water stripper bottoms for crude desalting and to a then new gas oil hydrotreater; installation of an upgraded spent caustic neutralization and stripping unit; and, improvements to slop oil handling in the dock area. ENSR reported that it understood those measures had not been implemented as of October 1997; and, that the average COD loading to the biotreatment system from September 1996 to April 1997 was 88,000 lbs/day, with daily maximum loadings in excess of 100,000 lbs/day (CIT0200041). The average COD loading during that period was nearly 80% greater than the average design load.

ENSR also noted "... the design storm event (10.2 inches of rain within a 24 hour period) can only be handled if the storm tanks are empty at the start; all key wastewater treatment equipment is functional; and, measures to reduce both dry weather wastewater flowrate and stormwater runoff to waste treatment are implemented." ENSR presented three relatively low cost options for reducing the dry weather flow to wastewater treatment by 967 gpm, or approximately 17% of the average dry weather design flow of 5,500 gpm:

- Reroute blowdown from cooling towers 7, 12 and 502 to direct discharge. Estimated project cost \$75,000. (265 gpm)
- Improve operation of sour water stripping (SWS) (pH) and reuse bottoms for desalting. Estimated project cost \$125,000 – 200,000. (312 gpm)
- Convert or change air conditioners, pump cooling, and analyzers to recirculated cooling. Estimated project cost \$430,000. (390 gpm)

ENSR also referenced prior recommendations to reduce peak storm water flow rates by diversion of additional wastewater drainage area to direct discharge and operation at reduced cooling tower blowdown rates during major storms (CIT0200045).

ENSR reported that as of 1997, 600 bbls/day (barrels per day) of free hydrocarbon entered the wastewater collection system on average, and that over half of the wastewater entering the collection system was uncontaminated or lightly contaminated. ENSR estimated that approximately 40% of the COD measured at biotreatment originated from free oil solubilized in the collection system. ENSR noted that spent caustics accounted for 31% of the total COD load and sour water stripper bottom bottoms 15% of the total COD load. To address excess COD loadings, ENSR made the following “first priority” recommendations:

- Improve segregation and routing of streams containing free oil to the oily waste sewer and dedicate use of two of the four API separators for treatment of wastewater from the oily waste sewer only. (Estimated COD reduction at biotreatment by 10 to 20%; estimated cost \$265,000).
- Recycle sour water stripper bottoms to the crude desalters. (Estimated net COD reduction 3%. Estimated cost \$200,000).

Storm Water Capacity and Evaluation Study

ENSR issued its final storm water capacity report in January 1998 titled “Stormwater Capacity Screening and Evaluation Study”, ENSR Document No. 1515-029-300 (CIT0088839-964). The principal conclusions from the study are presented below:

- *The original capacity of the existing Oily Water Sewer lift station, 28,000 gpm, is sufficient to handle the predicted peak flow rate of 25,000 gpm from a storm with 1 in 25 year intensity. The total installed pumping capacity of 40,000 gpm provides an additional margin of safety;*
- *The original design capacity of the existing Panama Canal lift station, 124,000 gpm, is sufficient to handle the predicted peak flow rate of 110,000 gpm from a storm with a 1 in 25 year intensity - modeling predicts that peak flow rate at the lift station is significantly attenuated by the time required for travel across unpaved surfaces, pipe size and the long travel times that result from an extensive collection system;*
- *Utilization of the full storm water surge volume (working volume with upper constraints) potentially available in tanks T-310, T-320 and T-330, and with flow to waste treatment ramped up to a maximum value of 10,000 gpm at the rate of 500 gpm/hr, sufficient storm water storage exists to handle the flow resulting from a 1 in 25 year storm without overflow to the former surge pond, however this high a treatment flow rate would be expected to result in non-compliance of the effluent discharge, as is discussed below;*
- *Operation of the wastewater treatment plant at the design flow rate of 10,000 gpm causes significant carryover of biomass from the secondary clarifiers, depleting the concentration in the aeration basins – operation at this rate for longer than about 6 hours would be expected to result in poor biotreatment performance for several days following the period of high flow, potentially leading to a violation of NPDES discharge limits – COD load is typically high during the heavy rainfall event and for a short time following as wastewater from the storm is worked off (due to sewer washout and high mixing energy in the wastewater tanks from the high flow rate);*
- *As the peak flow rate to wastewater treatment is to be limited to 7,000 gpm in order to avoid excessive loss of biomass, existing storm water surge volume is inadequate – the diminished differential between baseline flow and peak flow increases the storm water storage requirement to 9 MM gallons, (4.3 MM gallons for a 1 in 25 year, 24 hour storm) with continued rainfall over several days creating the worst case situation.*

ENSR reported three reasons why improvements to overall operating strategies and to the overall treatment system are required for permit compliance during and immediately after the design storm event, notwithstanding the 1993 design of the storm water management and wastewater treatment system was designed to handle a 1 in 25 year, 24-hour storm (CIT0088848):

- *The area draining to effluent treatment was 24% greater than that used as a basis of design in 1993;*
- *The working volume reserved for accumulation of storm water surge was reduced by 10 MM gallons from the original design basis by sludge accumulation, reduced high liquid levels to provide margin for prevention of tank overflow, and piping constraints which limited full utilization of available surge volume in the Equalization Tank;*
- *Biomass wash-out from secondary clarification was too high at the WWTP design flow rate of 10,000 gpm for sustained operation at this flow rate without impairing biotreatment performance for several days following the peak flow period.*

ENSR recognized that existing wastewater storage capacity was inadequate (CIT0088848). Besides additional storm water capacity, ENSR offered a number of other measures to prevent overflows of the tanks and diversions to the surge pond:

- *Modifications to operating strategies: remove sludge from storm water tanks on a routine basis; allow storm water tanks to be filled to 41 feet from 38 feet to provide additional capacity; and, remove sludge and allow normal operation of the equalization tank between 14 feet and a high liquid level (HLL) of 41 feet.*
- *Reduction in wet weather flow: contain storm water within the bermed landfarm (1.4 MM gallons over 24 hours; cost of \$20,000); and, redirect storm water from the API/DAF area sump and the contractor processing area (0.9 MM gallons over 24 hours; \$210,000).*
- *Reduction in base flow: reduce blowdown from cooling towers 7, 11 and 12 (0.3 MM gallons over 24 hours – project then in progress); recycle sour water stripper bottoms to the desalter (0.4 MM gallons over 24 hours; \$200,000).*

Not all of these recommendations were implemented and maintained.

ENSR noted that if future process changes or the addition of new refinery units add either dry or wet weather flow to waste treatment, it would be necessary to increase wastewater storage volume, increase wastewater treatment capacity, or find compensating reductions in dry or wet weather flow from some other area of the refinery. CITGO then added new refinery units and increased dry weather flow without adding supplemental wastewater storage and wastewater treatment capacity.

Storm Water Risk Study

ENSR provided to CITGO a report titled *Stormwater Capacity Screening and Evaluation Study, Risks Associated with Proposed Approach* in February 1998. That report also highlighted shortfalls in wastewater storage capacity and the wastewater treatment system and the impact of maintenance outages of critical wastewater treatment units on wastewater treatment system flow rates (CIT0183828-858). Loss of a clarifier was cited as creating the most severe operating problem for the wastewater treatment system with the worst case for the L-2 clarifier off line. Under that operating scenario, the maximum flow through the L-1 clarifier was cited at approximately 3,150 gpm, less than half of the available capacity of 7,000 gpm for the two

clarifiers (L-1, L-2) in service at that time (CIT0183842). Flows in excess of 3,150 gpm would require storage for future work-off.

ENSR also reported that if storm water flow exceeds design values, or critical equipment is out of service, and all available storm water surge tankage is filled it will become necessary to bypass waste treatment with a portion of the total wastewater flow. ENSR reported this will significantly increase the possibility of non-compliance with discharge regulations (CIT0183842).

CITGO Wastewater Storage and Treatment Operating Problems (May 1994 to August 2008)

As noted above, CITGO has experienced operating problems with the wastewater storage and treatment systems since they were put into service in May 1994. The major problems reported by CITGO wastewater treatment, environmental and engineering personnel and CITGO consultants include:

- Lack of adequate wastewater storage capacity
- Waste solids accumulation in wastewater storage tanks T-320, T-330
- Waste oil accumulation in wastewater storage tanks T-320, T-330
- Inability to take wastewater storage tanks T-320, T-330 out of service for cleaning and inspection because they must remain in service to respond to storms
- Use of concrete containment dike as an emergency surge basin in place of Primary Pond
- Inability to process storm water contributed to LPDES permit exceedances
- Lack of installed spares for API oil/solids separators and other wastewater treating equipment;
- Operating problems with API oil/solids separators
- Higher than anticipated loadings of waste oils and waste solids to API oil/solids separators and lack of solids removal and maintenance
- Mechanical problems with API oil/solids separators
- Lack of installed spare for dissolved gas flotation (DGF) unit
- Pass through of oil through primary treatment units
- Inadequate wastewater cooling capacity during certain high temperature weather conditions
- Excess COD loadings to biological treatment aeration tanks
- Excess oil loadings to biological treatment aeration tanks
- Oxygen transfer at biological treatment aeration tanks
- Lack of adequate secondary clarification for the biological treatment system
- Wash-out of biological solids from clarifiers when operated at higher than design flows

Many of these operating problems contributed to the June 2006 release and LPDES permit exceedances reported by CITGO (see Section E.4). CITGO did not address many of the most important issues cited by its staff and consultants prior to the June 2006 release.

CITGO Wastewater Treatment System Upgrades Prior to June 2006 Oil Release

Despite a number of operating issues, refinery expansions and associated recommendations by CITGO consultants and CITGO personnel, CITGO made few modifications to the WWT system during the period May 1994 to June 2006. Expansion of wastewater storage capacity was not one of them. Exhibit G is a schematic diagram on the WWT system as of December 2007.

ENSR reported CITGO made the following modifications to the wastewater collection system and implemented the operating changes noted below during the period May 1994 to 1997 (CIT0116916):

- Direct discharge of storm water from the West Tank Farm, Clifton Ridge and most of the South Tank Farm;
- Direct discharge of storm water from the Administrative Area (later changed back to discharge to the WWT system to avoid oil sheen discharges);
- Implemented a fee-for-disposal policy to reduce ballast water flow; and,
- Eliminated hot-lime softening wastewater through installation of a river water treatment system.

For several years prior to the June 2006 release, CITGO essentially stopped using and maintaining the oil skimmers on the wastewater storage tanks and allowed oil to accumulate in the tanks above design levels (CIT0277429). It was reported the oil skimmers did not work as designed since the initial installation.

By 1999, in lieu of installing the needed wastewater storage capacity, CITGO completed a project to pave the wastewater storage tank dike at a cost of \$1,500,000 to create an emergency containment area for untreated wastewaters. CITGO began reducing cooling tower blowdown during storm events and began removing solids from the storm water storage tanks (CIT0258774). Paving the containment dike was cited as a cost savings measure compared to a third wastewater storage tank that would provide concrete containment for diversions of untreated wastewaters. This would minimize hazardous waste clean-up costs compared to an event with a diversion to an earthen dike. CITGO also noted the project could be completed in a shorter time than a third wastewater tank. However, paving the dike did not address CITGO's inadequate wastewater storage capacity problem (CIT0120815). Operation in the mode of diverting untreated oily wastewater to the dike would, among other issues, defeat the purpose of maintaining benzene containing wastewaters under vapor control through the front half of the wastewater treatment system and would increase the risk of an oil release to the Indian Marais.

In 2001, CITGO installed a sulfuric acid injection system to partially neutralize some of the spent caustic before it enters the WWT system (CIT0123055).

In the 2002 time frame CITGO staff and consultants again recommended additional wastewater storage capacity, but CITGO did not approve the project until 2005 and did not complete the project until December 2007, after the June 2006 release. Between 2002 and 2006 expansions at the refinery added additional dry weather process wastewater flow, thus further reducing available capacity to manage storm water. The risk of spills increased each year because waste oils and waste solids were not removed from the wastewater storage tanks (CIT-TETRA000004-10).

By December 2005, CITGO installed fine bubble diffusers in one aeration tank (T-370) in response to high COD loadings to biotreatment (CIT0091538). The clarifier flow splitter box was modified to achieve more uniform flow distribution and the third clarifier (L-3) was commissioned in September 2005 (CIT0091539).

A naphthenic caustic removal project was implemented on January 10, 2006. Naphthenic caustic accounted for 10% of the caustic material processed at the WWT system, but 30% of the COD loading on the system (25,000 lbs/day). Naphthenic caustic generated during treatment of kerosene is a smaller volume caustic stream than sulfidic caustic generated elsewhere (CIT0091513).

3. CITGO Waste Oil and Untreated Oily Wastewater Release – June 19, 2006

Causes of the June 2006 Release

The two principal causes of the June 2006 waste oil and untreated oily wastewater release were inadequate wastewater storage capacity and accumulation of excessive amounts of waste oil and waste solids in the wastewater storage tanks.

On June 19, 2006, CITGO records show CITGO released from 99,000 up to 135,000 barrels (4,200,000 to 5,700,000 gallons) of waste oil and approximately 411,000 barrels (17,300,000 gallons) of untreated refinery wastewaters from T-320 and T-330 to the secondary containment dike for wastewater storage tanks.⁸ The dike was breached in a number of locations and CITGO reported it released 53,000 barrels of oil and 10.9 MM gallons of oily wastewater. Exhibit H is an aerial photograph of the CITGO wastewater treatment system taken shortly after the June 19, 2006 release.

CITGO produced the internal documents (presentations) listed below regarding the waste oil and untreated oily wastewater release. CITGO also filed a formal Revised Notification Report of the event to the LDEQ on October 20, 2006 (CITGO-LC0000539-15,16,17; CITGO-LC0000540-550):

*Lake Charles Oil Spill Investigation, Update to Executive Management
July 14, 2006 (CIT0047786-7843)*

Lake Charles Oil Spill Investigation, October 23, 2006 (CIT0047844-890)

The October 23, 2006 presentation is an update of the July 14, 2006 presentation. Exhibit I, Tables 1 and 2 present summaries of CITGO's staff analysis of root causes and significant key facts surrounding the waste oil and untreated oily wastewater release and recommendations to management for corrective actions (from July 23, 2006 presentation; same as October 23, 2006 presentation). The recommendations presented appear to be properly directed at understanding the hydraulic conditions at the site under design storm conditions; dry weather and wet weather flow reduction; and, effects of storage tank or equipment outages. However, many of the recommendations in this document are for items CITGO chose to ignore that were recommended previously to CITGO by its consultants and by CITGO operating staff to address shortfalls in wastewater storage capacity, flow reduction and operation and maintenance of the WWT (e.g., waste solids and waste oil removal from wastewater storage tanks).

CITGO cited four root causes of the June 2006 release:

- (1) Inadequate wastewater storage capacity;
- (2) Oil accumulation in the wastewater storage tanks and no measurements of the oil – CITGO estimated 99,000 barrels at the time of the release;
- (3) Accumulation of sludge in the wastewater storage tanks – CITGO estimated at 8 feet at the time of the release; and,
- (4) Gaps in an underground storm water junction box in the containment dike.

⁸ The term CITGO uses for waste oil collected in the wastewater storage tanks is "slop oil", which CITGO defines as follows: "What is slop oil? Also know as waste oil. It is a mixture of hydrocarbons from various processing units in the refinery. Components range from gasoline to heavy residual oil. The mixture released from CITGO has the approximate consistency of diesel fuel." (CIT0037846).

See Key Fact No. 1 in Table 2 of Exhibit I. I consider Root Cause No. 4 (unsealed storm water junction box) and Key Fact No. 1 (other points of oil release from the dike during the storm event) to be in the same category. They are characteristic of CITGO's failure to ensure the integrity of its containment system during construction of Tank 340. There were too many errors of judgment and an overall lack of planning and oversight during construction, notably given the inadequate wastewater storage capacity and the accumulation of waste oil and waste solids in the tanks. The end result was a catastrophic release of waste oil and untreated oily wastewaters. As described below, I believe the massive release could have been avoided had CITGO installed adequate wastewater storage capacity, adequate wastewater treatment system capacity and operated the wastewater storage tanks and wastewater treatment system properly prior to and at the time of the June 2006 storm event.

Wastewater Storage Capacity

See Key Fact No. 2 in Table 2 of Exhibit I. CITGO reported the volume of wastewater storage capacity required at the outset of the June 2006 rainfall event was 41 MM gallons, but that only 19 MM gallons was available. In the same document (July 14, 2006), CITGO reported the following information for the June 2006 release (11:00 pm June 18 to 5:00 pm June 19, 2006):

Wastewater pumped to WWT	50.2 MM gallons
Water processed at WWT	11.2
Required wastewater storage capacity	39.0
Available wastewater tank capacity	18.9
Overflow from tanks	20.1
Containment volume	15.8
Release to Indian Marais (07/14/06)	6.7 (2.4 MM gallons of rainfall to dike)

In an updated internal presentation dated October 23, 2006 (CIT0047867), CITGO reported different values for the release to the Indian Marais and the volume of rainfall that entered the containment dike:

Release to Indian Marais (10/23/06)	6.0 (1.7 MM gallons of rainfall to dike)
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On October 20, 2006, CITGO filed a revised report of the June 2006 incident with the LDEQ and reported the release of untreated wastewaters to the Indian Marais was 10.9 MM gallons (CITGO-LC0000543).

The volume of overflow to the Indian Marais reported in CITGO's internal investigation report presentation on July 14, 2006 was 6.7 MM gallons, of which 2.4 MM gallons was reported to be rainfall directly into the diked area. That value was revised in CITGO's October 23, 2006 internal presentation to 6.0 MM gallons, with 1.7 MM gallons of rainfall directly to the dike. CITGO did not address the design 25-year/24-hour storm event as part of these assessments, but concluded the WWT Unit was not capable of containing the 25-year design storm event (Root Cause No. 1, Table 1, Exhibit I).

For the assessments of the June 2006 release presented below, I used CITGO's reported values above for each item except the values reported on July 14 and October 23 for discharge to the Indian Marais. I considered 10.9 MM gallons that CITGO reported to LDEQ for the

discharge to the Indian Marais as CITGO's official report of the estimated discharge to the Indian Marais. I also calculated rainfall to the dike during the storm event at 2.52 MM gallons.⁹

Table 5 presents an assessment of the June 2006 storm event with the values described above. Note that in column 1 of Table 5, the values for total water to dike, containment volume and discharge to the Indian Marais do not balance because CITGO's reported discharge of 10.9 MM gallons made on October 20, 2006 apparently was calculated independently of the July 14, 2006 and October 23, 2006 CITGO internal presentations. The scenario evaluated in column 2 of Table 5 presumes T-310, T-320 and T-330 were operated at design levels pre-storm and integrity of the containment dike. The scenario evaluated in column 3 includes the conditions set out in column 2 and adds 10.1 MM gallons of wastewater storage capacity for T-340. In each case, the required untreated wastewater storage capacity is calculated at 39 MM gallons. These assessments show that if all design storm water capacity in Tanks 310, 320 and 330 was available (~ 25 MM gallons), the discharge of waste oil and untreated oily wastewaters to the Indian Marais would have been relatively small compared to the June 2006 release. However, the volume that overflowed from the tanks would have been 14.0 MM gallons without T-340 and nearly 4.0 MM gallons with T-340. This shows that CITGO would have needed more than one new 10 MM gallon wastewater storage tank to prevent the overflow from the tanks at the time of the June 2006 release.

Table 6 presents a similar assessment for the design 25-year/24-hour storm (10.25 inches). In this case, the amount of storm water generated from a design storm and discharged to the wastewater storage tanks was calculated from the estimated amount of storm water from the June 2006 storm and the ratio of the design storm to the June 2006 storm (10.25 inches/8.3 inches). The required untreated wastewater storage capacity is calculated at approximately 48 MM gallons for the design storm with the refinery area that drained to the wastewater treatment system as of June 2006. This analysis shows the possible overflows to the containment dike would have been 23.1 MM gallons without T-340, and 13.0 MM gallons with T-340 at design conditions. In each case a release to the Indian Marais is projected. T-340 was not brought on-line until December 2007.¹⁰ Currently, CITGO needs to take Tanks T-310, T-320 and T-330 out of service for cleaning and inspection but cannot safely do so. For example, the API standard 10 year tank inspections for these tanks are more than five years overdue.

⁹ Area of dike 487,032 square feet (CITGO-LC0000362) and 8.3 inches of rain for June 2006 storm event.

¹⁰ *Environmental Compliance Plan*. CITGO Petroleum Corporation, Lake Charles Manufacturing Complex, Storm Water Management. September 17, 2008. p.4.

Table 5
CITGO Petroleum Lake Charles Manufacturing Complex
Water Balance (MM Gallons)
June 18 – 19, 2006 Storm

Includes CITGO Reported Discharge of 10.9 MM gal and Tank 340 Working Volume (10.1 MM gal)

	Storm Event on 6/19/06	Low Level in T-310, 320, 330	Low Level in T-310, 320, 330 plus Tank 340
Water pumped to WWT	50.2	50.2	50.2
Water processed at WWT	11.2	11.2	11.2
Required tank storage	39.0	39.0	39.0
Available tank storage	18.9	25.0	35.1
Overflow from tanks	20.1	14.0	3.9
Rainfall to dike during storm	2.5	2.5	2.5
Total in dike	22.6	16.5	6.4
Containment volume	15.8	14.0	12.3
Total to Indian Marais	10.9	2.5	0.0

Table 6
CITGO Petroleum Lake Charles Manufacturing Complex
Water Balance (MM Gallons)
June 18-19, 2006 Storm and 25-Year/24-Hour Design Storm

Includes CITGO Reported Discharge of 10.9 MM gal and Tank 340 Working Volume (10.1 MM gal)

	Storm Event on 6/19/06	Design 25-yr Storm Low Level in T-310, 320, 330	Design 25-yr Storm Low Level in T-310, 320, 330 plus Tank 340
Water pumped to WWT	50.2	62.5	62.5
Water processed at WWT	11.2	14.4	14.4
Required tank storage	39.0	48.1	48.1
Available tank storage	18.9	25.0	35.1
Overflow from tanks	20.1	23.1	13.0
Rainfall to dike during storm	2.5	3.1	3.1
Total in dike	22.6	26.2	16.1
Containment volume	15.8	14.0	12.3
Total to Indian Marais	10.9	12.2	3.8

- Notes (1) For columns two and three, "Water pumped to WWT" estimated as follows:
 Process wastewater ~ 5,000 gpm @ 1,440 min/24 hrs = 7.2 MM gal
 Storm water = (10.25" rain/8.3" rain) * (50.2 MM gal – 5.4 MM gal) = 55.3 MM gal
 Water to WWTP = Process water (7.2 MM gal) + Storm Water (55.3 MM gal) = 62.5 MM gal
- (2) For columns two and three, rainfall to dike during a 25-year design storm calculated from reported surface area of dike (including tanks) of 487,032 ft² (CITGO-LC0000362) and 10.25 inches of rain.
- (3) Basis for containment volume of 15.8 MM gallons reported by CITGO could not be found. For column 2 in Tables 5 and 6, containment volume calculated as the sum of 12.3 MM gallons from CITGO/ReCon March 2008 (CITGO-LC0031045) and 1.7 MM gallons to account for T-340. Column 3 containment volume from CITGO/ReCon 2008.

Accumulation of Waste Oil and Waste Solids

CITGO had in place at the time of the June 2006 release a standard operating procedure (SOP-432-102) titled *Heavy Rain Condition* (CITGO-LC0000321-327). The stated purpose of the procedure is to provide instructions for normal Waste Water Treatment Plant (WWTP) operation prior to and during a heavy rain event. CITGO failed to follow the Heavy Rain Conditions SOP prior to and during the June 2006 storm event in a number of areas. Four are highlighted here:

- 2.0 Prerequisites
 - 2.1 In anticipation of a heavy rain event, every effort should be made to ensure that all critical equipment is in good operating condition and that all processing chemicals are in adequate supply.
 - 2.2 Prior to any rain event, every effort should be made to lower the levels in the T-310, Equalization Tank and the T-320 and T-330 Stormwater Tanks to the low level targets (see section 6.1.1 for targets).
- 6.0 Procedure
 - 6.1 Heavy Rain Conditions
 - 6.1.10 Every opportunity must be taken to utilize the storage volume available in T310. This volume is limited to the high level target for the tank of 38-feet. The overflow on this tank is 43 feet.
 - 6.1.15 When the levels in T320 and T330, reach 35 feet, verify all equipment and personnel have been removed from the inside firewall containment and that firewall drain valves inside firewall should be open and the drain valves outside of the firewall should be closed. (drive through gates will need to be sandbagged). Breakers to electrical equipment within the firewall area should be switched off.

Unfortunately, prior to and at the time of the June 2006 release, CITGO did not meet the prerequisites it established for itself to address anticipated heavy rains and also for any rain event. The wastewater storage tanks had excessive amounts of waste oils and waste solids. The waste oil removal equipment and the waste solids educators had not been operated effectively for a number of years prior to the June 2006 event. Also, one of four API oil/solids separators had been out of service for some time prior to the June 2006 release; and, at the time of the release two of three dissolved gas flotation (DGF) pumps were out of service. CITGO did not utilize available storage capacity in tank T-310 until after overflows of the other wastewater storage tanks had begun (CIT0427373). With respect to Section 6.1.15 above, CITGO did not secure all containment dike drains and had a number of breaches including the 16" firewater line and a below grade junction box that was part of the T-340 wastewater storage tank construction.

Release of Hazardous Waste

CITGO's release of untreated oily refinery wastewaters and waste solids caused a release of hazardous wastes to the Indian Marais (F037, D018). Petroleum refinery primary oil/water/solids separation sludge (F037) is a listed hazardous waste defined at 40 CFR §261.31(a) as follows:

"Any sludge generated from the gravitational separation of oil/water/solids during the storage or treatment of process wastewaters and oil cooling wastewaters from petroleum refineries. Such sludges include, but are not limited to, those generated in oil/water/solids separators; tanks and impoundments; ditches and other conveyances; sumps; and storm water units receiving dry weather flow."

Untreated wastewater solids and oils released from the breached containment dike that separated from the free oil and untreated wastewaters and subsequently settled in the Indian Marais are hazardous wastes under the above definition. Also, CITGO's untreated petroleum refinery wastewaters containing benzene is a characteristic hazardous waste (D018, 40 CFR §261.24(b)).

CITGO stated the following on December 9, 1998 (CIT0120805):

"If untreated wastewater were allowed to enter the Indian Marais CITGO could be required to remove all sludge from the marais. This would create a new unpermitted hazardous waste management unit. Removal, clean up and offsite disposal of the material from the marais would be very costly and is estimated to be about the same as the costs for the solids from the Ponds. As discussed previously, LDEQ would probably take enforcement action if this were to occur."

4. CITGO LPDES Permit Compliance History (1994 to 2009)

Prior to May 1994 CITGO reported a number of LPDES permit effluent exceedances, bypasses and unauthorized discharges and became subject to federal enforcement actions. Complaints were filed under Civil Actions 83-1367 on May 27, 1983 and 88-0171 on January 25, 1988 in the Western District of Louisiana. The United States and CITGO entered into a Consent Decree in each case in which CITGO agreed to a number of corrective actions.^{11,12} CITGO was also assessed a civil penalty of \$200,000 by the State of Louisiana for effluent exceedances during the period August 1981 through lodging of the 1983 Consent Decree.

May 1994 to December 2000

Table 7 presents a summary of LPDES permit effluent limit exceedances reported by CITGO for the period May 1994 to December 2000. This information was obtained from LPDES non-compliance notifications reported by CITGO to the Louisiana Department of Environmental Quality (LDEQ) and U.S. EPA Region VI. In March 1997, CITGO acknowledged it had 22 effluent limit exceedances and four diversions to the surge basin since May 1994 (CIT0200307).

Table 7
CITGO Petroleum Lake Charles Manufacturing Complex
Reported LPDES Permit Exceedances for Outfall 003
CITGO Reported Exceedances (May 1994 to December 2000)

Date	Outfall	Parameter	Permit Limits (lbs/day ex. pH)	Sample Value (lbs/day ex. pH)
Jul 1994	003	Oil & Grease (daily maximum)	2,459	6,929
Nov 1994	003	TSS (daily maximum)	5,402	6,175
		TSS (daily maximum)	5,402	10,741
		TSS (monthly average)	3,440	4,636
Dec 1994	003	TSS (daily maximum)	5,402	15,172
		TSS (monthly average)	3,440	4,363
Mar 1995	003	Zinc (monthly average)	24	28.8
		Zinc (daily maximum)	12	12.6
July 1995	003	Sulfide (daily maximum)	46	51
		Sulfide (daily maximum)	46	50
		Ammonia (daily maximum)	2,640	2,996
		Sulfide (monthly average)	21	27
		Ammonia (monthly average)	1,209	1,238
Aug 1995	003	Ammonia (daily maximum)	2,640	2,793
		Ammonia (daily maximum)	2,640	3,824
		Sulfide (daily maximum)	46	70
Jun 1996	003	TSS (daily maximum)	5,402	5,905
		Sulfide (daily maximum)	46	279
		Sulfide (monthly average)	21	39
July 1996	003	Ammonia (daily maximum)	2,640	3,112
Sep 1996	003	TSS (daily maximum)	5,402	8,078
Dec 1999	003	Sulfide (daily maximum)	46	63
Aug 2000	003	TSS (daily maximum)	5,402	6,129

¹¹ United States of America v. Cities Service Company, Consent Decree, Civil Action No. 83-1367, U.S. District Court, Western District of Louisiana.

¹² United States of America v. CITGO Petroleum Company, Consent Decree, Civil Action No. 88-0171, U.S. District Court, Western District of Louisiana.

January 2001 to December 2006

The LDEQ issued a Consolidated Compliance Order and Notice of Potential Penalty to CITGO on April 9, 2007, citing a number of alleged violations of LDEQ-issued permits and regulations, including alleged violations of LPDES Permit LA0005941.¹³ Table 8 presents a summary of the alleged LPDES permit violations for the period January 2001 to December 2006 for Outfalls 003A and 003C, the discharge from CITGO's polishing pond to the Calcasieu River. The LDEQ compliance order and notice also cites more than 20 alleged LPDES permit violations for discharges from other outfalls; however, my focus here is on alleged LPDES permit violations for Outfall 003.

Table 8
CITGO Petroleum Lake Charles Manufacturing Complex
LPDES Permit Effluent Violations Alleged by LDEQ
Consolidated Compliance Order & Notice of Potential Penalty
April 9, 2007

Date	Outfall	Pollutant	Permit Limit (lbs/day except pH)	Sample Value (lbs/day except pH)
Sep 2001	003C	Ammonia (daily average)	1,209	5,279
		Ammonia (daily maximum)	2,640	21,354
		BOD (daily average)	4,178	13,013
		BOD (daily maximum)	7,853	95,229
		Sulfides (daily average)	21	340
		Sulfides (daily maximum)	46	1,774
		TOC (daily average)	6,283	9,510
		TOC (daily maximum)	11,323	56,567
		TSS (daily maximum)	5,402	6,406
Oct 2001	003C	Ammonia (daily maximum)	2,640	3,283
Apr 2002	003C	Sulfides (daily average)	46	66
Jul 2002	003C	TSS (daily maximum)	5,402	6,003
Aug 2002	003C	TOC (daily maximum)	11,323	11,960
		TSS (daily maximum)	5,402	7,599
Mar 2005	003C	Ammonia (daily average)	1,209	1,374
		Ammonia (daily maximum)	2,640	3,689
		BOD (daily maximum)	7,583	9,801
		pH (excursions > 60 minutes)	0	2
		pH (excursions, total minutes)	446	467
		Sulfides (daily maximum)	46	48
		TOC (daily maximum)	11,323	21,117
		TSS (daily average)	3,440	4,828
		TSS (daily maximum)	5,402	15,045
Aug 2005	003A	Sulfides (monthly average)	25.3	51
		Sulfides (weekly average)	56.3	168
		TOC (monthly average)	9,941	10,642
Sep 2005	003A	TOC (monthly average)	9,941	15,300
		TSS (weekly average)	6,188	9,028

¹³ Letter from (Peggy M. Hatch, Administrator, Enforcement Division, Department of Environmental Quality, State of Louisiana, Baton Rouge, LA) to (CITGO Petroleum Company, c/o CT Corporation Service, Baton Rouge, LA). *Consolidated Compliance Order & Notice of Potential Penalty, Enforcement Tracking No. MM-CN-06-0058, Agency Interest No. 1250.* April 9, 2007.

Date	Outfall	Pollutant	Permit Limit (lbs/day except pH)	Sample Value (lbs/day except pH)
Oct 2005	003A	Ammonia (monthly average)	1,813	1,822
		Ammonia (weekly maximum)	3,960	7,866 ¹⁴
Nov 2005	003A	Ammonia (weekly maximum)	3,960	4,253
		BOD (monthly average)	4,518	4,553
		TOC (monthly average)	9,941	11,713
Dec 2005	003A	Oil & Grease (monthly average)	1,485	1,635
Feb 2006	003A	Ammonia (monthly average)	1,813	1,907
May 2006	003A	Sulfides (monthly average)	25.3	26
Jun 2006	003A	Ammonia (weekly average)	3,960	6,165
		Oil & Grease (monthly average)	1,485	1,656
		Sulfides (monthly average)	25.3	60
		Sulfides (weekly average)	56.3	209
		TSS (monthly average)	3,961	7,401
		TSS (weekly average)	6,188	21,840
Jul 2006	003A	BOD (monthly average)	4,518	8,833
		BOD (weekly average)	8,863	12,514
		Oil & Grease (monthly average)	1,485	3,420
		Oil & Grease (weekly average)	2,824	4,899
		Sulfides (monthly average)	25.3	124
		Sulfides (weekly average)	56.3	344
		TOC (monthly average)	9,941	12,771
		TSS (monthly average)	3,961	7,022
		TSS (weekly average)	6,188	20,078
Aug 2006	003A	Sulfides (weekly average)	56.3	60

January 2007 to August 2009

The LDEQ subsequently issued an Amended Compliance Order and Notice of Potential Penalty to CITGO on July 22, 2008 citing additional alleged violations of LDEQ-issued permits and regulations, including additional alleged violations of LPDES permit LA0005941.¹⁴ These additional alleged violations for Outfall 003 are included in Table 9. The amended compliance order also included five additional violations for discharges from other CITGO outfalls.

Table 9
CITGO Petroleum Lake Charles Manufacturing Complex
LPDES Permit Effluent Limit Exceedances Reported by CITGO
January 2007 to August 2009

Date	Outfall	Pollutant	Permit Limit (lbs/day except pH)	Sample Value (lbs/day except pH)
Jun 2007	003	Ammonia (daily maximum)	3,960	8,930
Jul 2008	003	Ammonia (daily average)	1,813	2,063
		Ammonia (daily maximum)	3,960	4,499
Sep 2008	003	Bypass of approximately 139,000 gallons of untreated process water and contaminated storm water		Not monitored
Oct 2008	003	Ammonia (daily maximum)	3,960	4,897

¹⁴ Letter from (Lourdes Iturralde, Administrator, Enforcement Division, Department of Environmental Quality, State of Louisiana, Baton Rouge, LA) to (CITGO Petroleum Corporation, c/o CT Corporation Systems, Baton Rouge, LA). Amended Consolidated Compliance Order & Notice of Potential Penalty, Enforcement Tracking No. MM-CN-06-0058A. Agency Interest No. 1250. July 22, 2008.

My assessment of these reported LPDES effluent exceedances and alleged violations is presented in Section F.4.

In addition to reported LPDES permit effluent limit exceedances, CITGO records show a number of diversions of untreated wastewaters to the Surge Pond and other “near misses” with respect to the LPDES permit.¹⁵ Exhibit J presents a tabular summary of diversions of untreated oily wastewaters to the surge pond and the wastewater storage tank secondary containment dike, recorded “near miss” situations and a chart of wastewater storage tank levels from August 1996 to July 2006. During the period 1995 to 2008 CITGO records show eight diversions to the surge pond and the wastewater storage tank secondary containment dike. In addition to the June 2006 release, there were intentional diversions to the containment dike in July 2007 and July 2008. The July 2008 event also included an overflow to the surge pond from the Panama Canal. Exhibit J contains a chart of wastewater storage tank levels and a table of “near misses” recorded by CITGO. These documents show there were more than 75 instances where tank levels were reported in excess of 30 feet. Of those, approximately 30 were above 40 feet. The tank overflow level is 43 feet. The diversions and the relatively high number of “near miss” high tank levels during the period August 1996 to July 2006 highlight the high risk nature of the CITGO wastewater storage system design and wastewater storage and treatment system operations. Exhibit J also contains analytical data for untreated oily wastewaters diverted to the surge pond.

¹⁵ For wastewater storage CITGO defines a “near miss” as a wastewater storage tank level exceeding 30 feet as a result of a storm event (CIT0120795).

F. CITGO's Avoided and Delayed Costs and Recommended Corrective Measures

The following sections present my opinions regarding: (1) measures CITGO should have taken to provide effective wastewater management and treatment prior to the June 2006 waste oil and untreated oily wastewater release; (2) measures CITGO should have taken to avoid reported LPDES permit exceedances at Outfall 003; (3) inadequacies of CITGO's current wastewater collection, storage and treatment facilities and operating practices to prevent releases from the collection and storage systems while maintaining compliance with CITGO's LPDES permit and related environmental regulations; and (4) recommended corrective measures. Where applicable, I have also presented estimates of costs that CITGO avoided or delayed with respect to the June 2006 waste oil and untreated oily wastewater release and for facilities I believe should have been installed to ensure effective wastewater management and treatment and compliance with applicable environmental permits and regulations.

1. Petroleum Refinery Process Wastewater and Storm Water Management Systems

There are approximately 140 operating petroleum refineries in the United States.¹⁶ Crude oil refining capacity ranges from less than 10,000 barrels per day to more than 500,000 barrels per day. Refining capacity at the Lake Charles Manufacturing Complex has been reported recently at 495,000 barrels per day (CITGO-LC0031040), making the Lake Charles Manufacturing Complex the fourth largest petroleum refinery in the U.S in terms of refining capacity. In general terms, the larger the refining capacity, the larger will be the land area (footprint) of the refinery process units and ancillary facilities including tank farms, utilities and wastewater treatment systems. The larger the land area occupied in a given location, the greater the volume of surface runoff generated during precipitation events. Management of storm water is a significant issue at all refineries, particularly at larger refineries located in areas where intense rainfall events occur.

The American Petroleum Institute defined three broad categories of storm water management systems that can be used at petroleum refineries¹⁷:

Completely segregated. In a completely segregated system essentially all runoff is segregated from process wastewater and handling or treatment of runoff is separate from handling or treatment of process wastewater.

Partially segregated. In partially segregated systems storm runoff in process areas drains to process sewers for treatment along with process wastewater, and all other runoff from non-process areas is collected separately and handled or treated separately.

Combined. In combined systems all storm water runoff from the entire plant is combined with process wastewater for treatment and discharge in one or more systems.

¹⁶ NPRA *United States Refining and Storage Capacity Report (Refinery Capacity Report, January 1, 2009)*. National Petrochemical and Refiners Association. Washington, DC. August 2009.

¹⁷ *Manual on Disposal of Refinery Wastes, Volume on Liquid Wastes, Chapter 21 – Handling Storm Water Runoff*. American Petroleum Institute, Washington, D.C. 1980.

Completely segregated systems are generally not practical for all but new source refineries or new production units constructed at existing refineries. Even in those instances the preferred approach is often to collect and treat with process wastewater the surface runoff from the immediate process area to minimize the potential for unauthorized discharges of oil and hydrocarbons. Given that there have been no new source refineries constructed in the United States in recent times, the great majority of U.S. refineries are operated with partially segregated storm water management systems. Few, if any, refineries have totally combined storm water/process water systems. This is due to cost and practical design considerations.

CITGO operates a partly segregated storm water management system at the Lake Charles Manufacturing Complex; however, the area drained to the wastewater treatment system is large and CITGO has not implemented a number of identified wet weather flow reduction measures.

There are five interrelated principal hydraulic components that must be considered and addressed properly to design and size petroleum refinery process water and storm water management and treatment systems:

- Dry weather process wastewater flow;
- Utility and non-contact cooling water flows not contaminated with hydrocarbons;
- Wet weather (or storm water) flow (contaminated and uncontaminated);
- Wastewater storage capacity; and,
- End-of-pipe wastewater treatment system.

Dry weather process wastewater flow comprises wastewaters generated in the refinery process units and ancillary activities, including wastewater flows generated during routine maintenance and planned refinery turnarounds. These wastewater streams typically contain waste oils, hydrocarbons and related refinery process wastewater pollutants: suspended and dissolved solids, ammonia-N, phenols, sulfides, polynuclear aromatic hydrocarbons and others. There are opportunities to minimize the volume of process wastewaters that must be treated in end-of-pipe wastewater treatment systems through pretreatment and reuse of certain process wastewaters in other refinery processes. Minimizing process wastewater flow and organic loading can serve to minimize the size of the end-of-pipe wastewater treatment system required to meet applicable NPDES permit effluent limits. Treatment of concentrated process wastewater streams at the source is common throughout the petroleum refining industry (e.g., sour water stripping, benzene stripping).

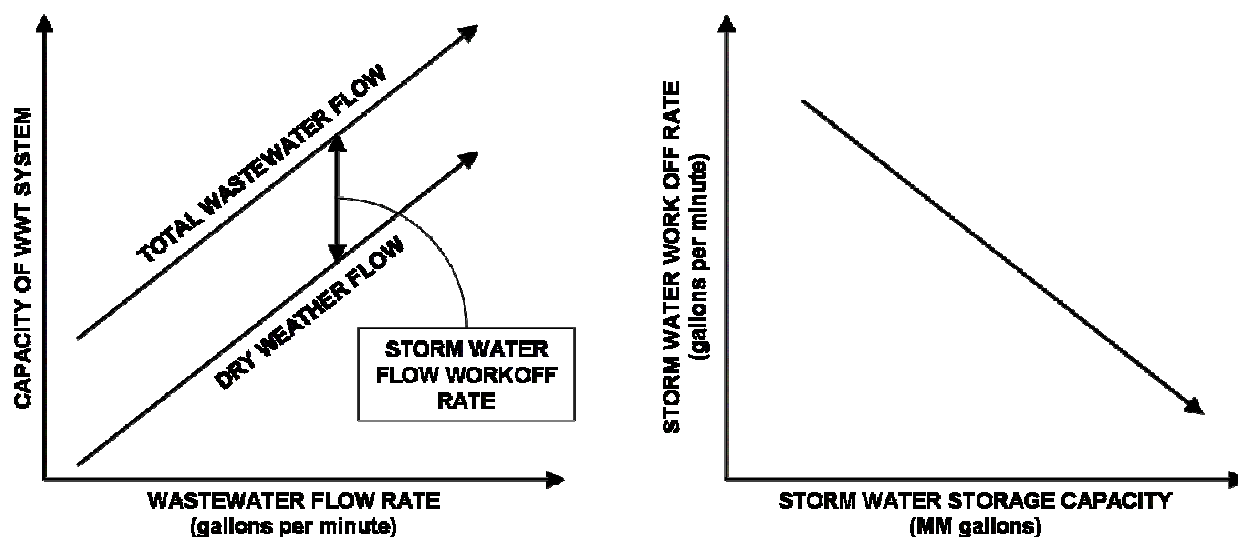
Utility wastewaters are generated from treatment of incoming refinery source water for various applications. Treatment typically includes removal of sediment and silt from incoming water and water softening and demineralization for boiler water and other refinery applications. Non-contact cooling waters are used for cooling of refinery and utility processes and may be operated on a once-through basis where incoming source water is passed through heat exchangers (heat transfer devices) and returned to the water source with essentially no treatment other than biocide applications to retard microbiological fouling of heat transfer surfaces. In many refineries at least some, and in some cases, a large portion of the non-contact cooling water is recycled internally. In these recycle systems limited volume blowdowns are discharged to maintain acceptable recycle system chemistry. Utility and non-contact cooling water streams typically contain dissolved minerals in the form of total dissolved solids (TDS), chlorides, sulfates, and typically do not contain process wastewater pollutants such as those noted above. Utility and non-contact cooling waters thus do not require extensive end-of-pipe treatment, if any at all, compared to refinery process wastewaters.

Because petroleum refinery processes are located outdoors and refineries encompass relatively large land areas for process units, tank farms and utility areas, considerable volumes of storm water are generated, particularly at those refineries located in high rainfall areas. Broadly speaking there are three categories of storm water that are generated at petroleum refinery sites: (1) process area storm water that has a reasonably high likelihood of containing hydrocarbons and other process water contaminants; (2) storm water from non-process areas within the refinery battery limits that has the potential to contain process water pollutants; and, (3) storm water that has little or no potential to contain process water pollutants. As noted above, storm water from refinery process areas is typically collected and treated with refinery process wastewaters; storm water that has the potential to contain process water pollutants can either be collected and treated with process wastewaters, or collected and treated separately, if necessary, and discharged separately from treated process wastewaters. Management of refinery storm water has a material affect on the design and size of wastewater storage systems and end-of-pipe wastewater treatment systems.

It is usually cost-effective to include temporary wastewater storage as a component of a petroleum refinery wastewater management system, particularly where the storm water component of the flow to be treated in an end-of-pipe treatment system is relatively large in relation to the dry weather process wastewater flow and is highly variable. The function of temporary wastewater storage is to have at the outset of a storm available storage capacity to contain the volume of storm water generated such that the collected storm water can be metered at controlled rates to the end-of-pipe wastewater treatment system. This is important because wastewater treatment systems typically operate best when variability of hydraulic and waste loadings are reasonably well controlled. To the extent uncontaminated or contaminated storm waters are co-mingled (mixed) with process wastewaters as at the CITGO Lake Charles Manufacturing Complex, the mixture becomes process wastewaters subject to the federal categorical effluent limitations guidelines at 40 CFR Part 419 and NPDES permit requirements. Collection of refinery storm waters in temporary storage tanks requires considerations to manage waste solids and waste oils that will collect in the tanks, particularly where storm waters are mixed with refinery process wastewaters.

The size (i.e., capacity) of facilities to treat petroleum refinery wastewaters in end-of-pipe wastewater treatment system is directly related to the dry weather process wastewater flow and a storm water component of wastewater flow derived from the storm water storage capacity in terms of a “work-off” rate. The maximum “work-off” rate from wastewater storage is the difference between the dry weather process wastewater flow and the maximum design hydraulic capacity of the end-of-pipe wastewater treatment system, or the maximum hydraulic rate the end-of-pipe treatment system can be operated while maintaining compliance with NPDES permit effluent limits and related environmental regulations, if that rate is less than the maximum design hydraulic capacity. Thus, the size (design capacity) of the end-of-pipe wastewater treatment system is inversely related to the size (volume) of the temporary wastewater storage capacity. Petroleum refinery end-of-pipe wastewater treatment facilities typically comprise primary treatment for gross oil and solids removal (API oil/solids separators, dissolved gas flotation units), pH control, wastewater flow and pollutant loading equalization and biological treatment. Many refineries have supplemental metals precipitation steps for removal of metals (e.g., selenium) and filtration and granular activated carbon (GAC) adsorption for supplemental removal of phenolic compounds and toxic organic pollutants. CITGO does not have such treatments at the Lake Charles Manufacturing Complex.

The following diagrams illustrates the relationship of the above hydraulic components to the size (design capacity) of petroleum refinery end-of-pipe wastewater treatment facilities:



The following conceptual design considerations, if followed to the extent practical at a given petroleum refinery, will result in a sound design for overall process wastewater and storm water management:

- Minimize process water use and minimize generation of process wastewater through reuse and recycle of process waters;
- Maximize segregation of process wastewaters from non-contact cooling waters and from uncontaminated and lightly contaminated storm waters;
- Maximize treatment of concentrated process wastewaters at the source, (e.g., neutralization of spent caustic streams, sour water stripping, separate pretreatment of benzene-containing wastewaters);
- Provide sufficient volume of wastewater storage capacity to manage effectively process wastewater and storm water generated from the design storm; and,
- Optimize the efficiencies of the design of individual treatment units and provide adequate numbers of treatment units to accommodate maintenance outages of critical units.

2. CITGO's Approach to Process Water and Storm Water Management

CITGO commissioned the wastewater collection, storage and treatment systems (WWT system) as outlined by the BDC design set out in Table 2 in May 1994. CITGO made two fundamental design decisions during the early 1990's when the conceptual process engineering and design engineering phases for the WWT system were underway:

- CITGO chose to continue to collect and co-treat contaminated and uncontaminated storm water from a considerable portion of the site with process wastewaters regulated under the categorical effluent limitations guidelines and the LPDES permit. This decision directly affected the volume of wastewater storage capacity required, the sizing of the end-of-pipe wastewater treatment system and the sizing of the secondary containment structure for the wastewater storage tanks. The end-of-pipe wastewater treatment system must be designed and sized to treat the dry weather process wastewater flow plus a storm water flow component derived from the total volume of wastewater collected and a design work off rate for the collected wastewater. This design approach results

in the mixing of oily process wastewaters and uncontaminated and contaminated storm waters in the collection system, thus creating a greater volume of process wastewaters that require treatment prior to discharge under the LPDES permit. This approach directly links the volume of storm water generated, the size (volume) of needed wastewater storage capacity and the capacity of the end-of-pipe wastewater treatment system.

- CITGO chose to address compliance with the benzene NESHAPs for wastewaters by providing vapor control for benzene-containing wastewater streams co-mingled (mixed) with wastewater streams that contained little or no benzene, as opposed to providing dedicated pretreatment systems for isolated concentrated benzene-containing wastewaters. This decision effectively required CITGO to provide containment and vapor control of all wastewater streams (process wastewater and contaminated storm water) in the collection systems, in the wastewater storage tanks and at the end-of-pipe wastewater treatment system through the API oil/water separators and the dissolved gas flotation (DGF) units where vapors are removed and subsequently destroyed. This decision also effectively limits CITGO's ability to divert untreated wastewaters containing benzene to open containment structures while, at the same time, maintaining compliance with benzene NESHAPs.

The above decisions by CITGO were opposite recommendations made by CITGO's consultants in 1991 that called for substantial separation of process wastewaters and storm waters; treatment and reuse of lesser contaminated wastewaters collected in the Panama Canal; and, a dedicated benzene steam stripping system to comply with the benzene NESHAPs (CIT0456968-7157). Given the site-specific circumstances at the CITGO Lake Charles Manufacturing Complex as described in the engineering reports commissioned by CITGO, I find those recommendations represent good wastewater engineering practice that were based on conventional and well known wastewater management and treatment technologies. They would have provided for further segregation of highly contaminated wastewaters; further segregation of storm waters and cooling waters that do not require substantial or any treatment prior to discharge; and, they would have provided for isolation and treatment of concentrated benzene-containing wastewaters "at the source" as opposed to treatment of co-mingled and diluted wastewater streams "end-of-pipe".

Historically (prior to May 1994), storm water from a considerable portion of the CITGO refinery was mixed with oily process wastewaters and discharged to the Primary Pond (27 acres), more or less as in a combined process wastewater/storm water sewer system. It was essentially a large lagoon system with substantial capacity (50 to 60 million gallons) to absorb storm flows prior to end-of-pipe treatment. The May 1994 wastewater storage system comprising wastewater storage Tanks 320 and 330 and part of equalization tank T-310 essentially replaced the Primary Pond with less than one-half the wastewater storage capacity. That CITGO experienced a number of overflows and discharges from the Primary Pond prior to 1994 was indicative of the large volume of storm water collected at the Lake Charles Manufacturing Complex. This was apparently not fully considered in the final BDC 1993 design.

While the approach taken by CITGO to mix process wastewaters and large volumes of storm waters prior to treatment is not prohibited by any regulation, in my opinion it was not the optimum approach with respect to wastewater management. Nonetheless, once CITGO made those design decisions, CITGO was obligated to provide the necessary capacity in its wastewater collection and storage systems and wastewater treatment systems to ensure compliance with its LPDES permit; to ensure effective spill prevention and control; and, to

ensure compliance with the benzene NESHAPs and RCRA regulations. Unfortunately, as demonstrated by the June 2006 waste oil and untreated oily wastewater release and CITGO's compliance record with its LPDES permit over a number of years, CITGO has failed on nearly all counts. Furthermore, CITGO took a calculated high risk design approach in 1992 and 1993 and continues to take approaches that do not fully address wastewater management problems resulting from its fundamental design decisions made during the early 1990's. CITGO still has not constructed a wastewater storage and wastewater treatment system capable of containing and treating wastewaters from a 25-year/24-hour storm.

Not only did CITGO fail to install adequately sized and adequate numbers of wastewater storage and treatment units with the initial installation in May 1994 (the physical plant and equipment), CITGO did not operate and maintain properly some of the critical wastewater storage and wastewater treatment facilities it did install. For example, waste solids and waste oil were allowed to accumulate in the wastewater storage tanks for several years prior to the June 2006 waste oil and untreated oily wastewater release. Waste solids management was such that the API oil/water separators became filled with sludge at times. That contributed to equipment breakdowns and excess waste oil discharges to downstream treatment units. The biological treatment system was frequently overloaded and the temperature of the wastewater feed to the biological treatment system was not adequately controlled during several hot weather periods. Microbiological solids that washed out of the clarifiers during treatment operations at high flow contributed to excess sulfide discharges and sulfide effluent limit exceedances.

CITGO commissioned several engineering design studies and hydraulic modeling studies for the WWT system started up in May 1994, but did not implement a number of pretreatment, flow reduction and waste loading reduction and control measures upon which the original 1993 treatment system process design was predicated:

- Install a new caustic waste stream neutralization unit (COD load reduction). This was eliminated for cost reduction (\$2,700,000) and CITGO's reported inability to quantify justification for the system (CIT0200041, CIT0178338). Without this system, CITGO consultants report that excess COD loadings reach the biotreatment units because additional COD loading is developed in the collection system through solubilization of a portion of the 600 barrels of free hydrocarbons that enter the wastewater collection system on a daily basis (CIT0116897). The BDC 1993 design report shows existing neutralization of spent caustic streams (CIT0090868, 871). It also includes a recommendation to upgrade and put back in service the caustic neutralization unit, as well as to segregate the caustic stream to reduce extraction of soluble COD (CIT0090870).
- Reuse sour water stripper bottoms for crude desalting and in a then new gas oil hydrotreater unit (CIT0200041).
- Improve slop oil handling in the dock area (CIT0200041).
- Contain and/or divert for direct discharge clean storm water collected in the West, South and Intermediate Tank Farms and Administration area, among others (CIT0090871, CIT0090874).

By not completing these projects, CITGO caused the influent hydraulic and waste loadings to the wastewater treatment to be greater than design levels, thus placing additional operating stress on the system.

Furthermore, the 1993 design for wastewater treatment system appears to have been based on low estimates of untreated refinery wastewater characteristics (Primary Pond effluent data). The Primary Pond removed significant amounts of wastewater solids through gravity settling and provided buffering capacity for refinery upsets and the resulting high variability in untreated wastewaters. The biological treatment portion of the wastewater treatment system appears to have been based on a low estimate of the organic (COD) loading:

- Baseline COD loadings that were intended to represent the influent quality to the new WWT system were developed from Primary Pond (Surge Pond) effluent data, which did not take into account untreated wastewater loadings to the Surge Pond and COD, solids and oil removal afforded by the relatively long residence time within the Surge Pond (CIT0137832-6); and,
- As noted above, additional COD loading resulted from solubilization of free hydrocarbons within the collection system leading to the WWT system.

See Section E.1 and Exhibit F for my review of CITGO's engineering design for the API oil/solids separators, the dissolved gas flotation (DGF) units, the biological treatment aeration tanks and the biological treatment system clarifiers.

CITGO took a high risk approach to the WWT treatment system installation by eliminating from the installation system a number of wastewater storage and treatment units that would have provided additional storm water storage capacity; installed spares for critical wastewater pretreatment units; and increased wastewater treatment capacity (see Table 3, CIT0098350). Reference is made to Table 4 for a list of CITGO's high risk cost cutting measures.

3. Wastewater Storage Capacity, Water Balances and Flow Reduction Measures Associated with the June 2006 Waste Oil and Untreated Oily Wastewater Release

The threshold question here is: what wastewater collection and storage facilities, if properly operated and maintained, would have prevented the June 2006 overflow of the wastewater storage tanks and release of waste oil and untreated oily wastewater to the Indian Marais and the Calcasieu River?

This question is directed at the hydraulic design, installation and operation of the wastewater collection and storage systems rather than at the design, installation or operation of the end-of-pipe wastewater treatment facilities. I do not consider discharge or diversion of untreated refinery wastewaters to the wastewater storage tank containment dike an acceptable practice given the quality of CITGO's untreated petroleum refinery wastewaters and the regulatory issues associated with such discharges or diversions.¹⁸

I evaluated the following aspects of CITGO's wastewater collection and storage systems with respect to the June 2006 oil release:

¹⁸ Discharge of untreated comingled petroleum refinery wastewaters to the containment dike could result in releases of benzene above reportable quantities under CERCLA; unauthorized management of benzene-containing wastewaters and releases of benzene (D018 characteristic hazardous waste) in excess of levels authorized under the benzene NESHAPs; loss of secondary containment capacity for spill control; and, generation and disposal of a listed hazardous waste from settling in the containment dike of solids and oils contained in the untreated refinery wastewaters. Petroleum refinery primary oil/water/solids separation sludge is a listed RCRA hazardous waste under 40 CFR §261.31(a), EPA hazardous waste number F037.

Wastewater Collection and Storage Capacity
 Water Balances for June 2006 Storm Event
 Operation of Wastewater Storage Tanks; CITGO Standard Operating Procedures
 Dry Weather Process Wastewater and Wet Weather Flow Reduction

Wastewater Collection and Storage Capacity

Table 10 presents a summary of wastewater storage capacity information considered by CITGO and its consultants during the period when replacement of the Primary Pond (surge pond) was being evaluated and leading to the June 2006 release (1987 through 2006). The available usable wastewater surge capacity of the Primary Pond was reported at 50 to 60 MM gallons in 1987. Engineering Science (ES) determined a base case storm water flow storage capacity requirement of 47 MM gallons. The base case assumed no dry weather or wet weather flow reduction measures. ES also developed and recommended a preliminary design based on a 10-year 24-hour storm of 8.5 inches; a tributary drainage area of nearly 600 acres; 37.8 MM gallons of wastewater storage capacity; and, a wastewater treatment system processing rate of 5,500 gpm (4,000 gpm process wastewater; 1,500 gpm storm water). For the recommended wastewater storage capacity of 37.8 MM gallons, ES presumed diversion and direct discharge of clean storm water from west end units. The recommended storage capacity was based on a 10-year storm and is nearly double the dedicated wastewater storage installed by CITGO in May 1994 ostensibly to contain untreated oily wastewater from a 25-year storm.

During the engineering design process for the wastewater storage and wastewater treatment systems installed in May 1994, BDC reported the early design for a 25-year storm included wastewater storage capacity of 34 MM gallons; and, that CITGO requested 10 MM gallons of additional wastewater storage capacity, for a total of 44 MM gallons (CIT0267467). BDC reported CITGO requested the additional volume to address potential tank outages. The final December 1993 BDC design that was approved and installed by CITGO provided dedicated wastewater storage capacity of less than 20 MM gallons¹⁹, which is less than half the amount recognized as needed by CITGO in 1992. Had 44 MM gallons of wastewater storage capacity been installed in May 1994, and the storage tanks were operated properly prior to the June 2006 storm event, the massive waste oil release could have been avoided.

BDC's December 1993 design was based on a 25-year/24-hour storm (10.25 inches) and approximately 118 acres of drainage area to WWT. The 25-year/24-hour storm is a generally accepted design standard for wastewater storage systems and SPCC plan secondary containment dikes. It included a reported 20.2 MM gallons of storm water storage capacity and a maximum wastewater treatment system processing rate of 10,000 gpm, although BDC cited 7,000 gpm as an optimal processing rate for operation of the API separators and the dissolved gas flotation (DGF) units. ENSR reported in 1998 the refinery drainage area to wastewater treatment was approximately 208 acres; recommended a maximum wastewater treatment processing rate of 7,000 gpm to retain biosolids in the biological treatment system and avoid LPDES permit violations; and, calculated available storm water storage capacity at 25.4 MM gallons, presuming approximately 7.0 MM gallons of available storage capacity in Tank 310 (Equalization Tank) and the wastewater storage tanks were operated at their normal liquid levels (NLLs) of 5.5 feet prior to a storm event.²⁰ ENSR reported in 1998 the required storm

¹⁹ The December 1993 BDC design report lists the combined capacity of wastewater storage tanks at T-320 and T-330 at 20.2 MM gallons (see Table 2 and footnote to Table 2). However, based on the stated design normal lower level and the high liquid level, the actual usable storage capacity was less than 20 MM gallons.

²⁰ The term "normal liquid level" or NLL is used by ENSR and CITGO to describe the wastewater storage tank pre-storm design condition for purposes of estimating usable wastewater storage capacity and

water storage capacity for the 25-year design storm event was approximately 34.2 MM, or more than the capacity of three 10 MM gal wastewater storage tanks.

In December 2006, after completing a review of the June 2006 waste oil and untreated oily wastewater release and examination of the volume of storm water expected during a 25-year design storm event, ENSR reported the storage volume required to avoid overflow from the three wastewater storage tanks (T-320, T-330, T-340) to the containment dike was 35.8 MM gallons under certain operating assumptions (CITGO-LC0000530-532). These operating assumptions are reviewed in Section F.3. Today, CITGO does not have adequate wastewater storage volume to contain a 25-yr/24-hour storm in wastewater storage tanks.

wastewater storage tank working volume. That term has had little meaning in practice because since at least the year 2000 CITGO has not consistently maintained Tanks 320 and 330 at design pre-storm operating levels. Consequently any calculations of usable wastewater storage tank storage capacity or wastewater storage tank working volume based on design pre-storm NLL's overestimate actual usable storage capacity.

Table 10
CITGO Petroleum Lake Charles Manufacturing Complex
Wastewater Storage Capacity for Replacement of Primary Pond

	Primary Pond (pre 1987)	Engineering Science (1987)	BDC (1992)	CITGO (1992)	BDC (1993 Design)	ENSR (1998)	ENSR (2006)
Design Rainfall Event		10-yr/24-hr 8.5 inches			25-yr/24-hr 10.25 inches 25-yr/1-hr ~ 5 inches	25-yr/24-hr 10.25 inches 25-yr/1-hr ~ 5 inches	25-yr/24-hr 10.25 inches 25-yr/1-hr ~ 5 inches
Refinery Drainage Area To Treatment (acres)	~ 660	597.8			117.86	208.09	225.99
Design Dry Weather Flow (gpm)		4,000			5,340	5,000	7,000 ²¹
Design Wet Weather Flow (gpm)		1,500			4,660 (by difference)	500 gpm/hr to 7,000 gpm total flow	5,500 (by difference)
Wastewater Treatment Capacity (gpm)		5,500			10,000 (maximum hydraulic capacity) 7,000 (optimal flow for API and DGF operation)	7,000 (maximum flow to avoid biosolids washout from two clarifiers)	12,500
Stated Available, Recommended or Requested Storm Water Capacity (MM gallons)	50 to 60 (Available, as of 1987)	37.8 (Recommended)	34 (Rec) ²²	44 (Requested)	20.2 (T-320, 330) ²³ Partial volume from T-310 (3.1 MM gal) NLL 31 ft to 43 ft	18.4 (T-320, 330) ²⁴ 25.4 (T-310, 320 & 330)	29.9 (T-320, 330 & 340) 35.8 (above plus T-310)
Stated Required Storm Water Capacity (MM gallons)		47.0 (Base Case) ²⁵			20.4	34.21	35.8 (Table 6, Case 2)

²¹ Process wastewater dry weather flow increase attributed to refinery expansion.

²² BDC reported that 34 million gallons was recommended in the early design for the 25-year storm. BDC also reported that CITGO had requested another 10 million gallons above the calculated minimum to address potential tank outages (CIT0267467, February 7, 1992).

²³ BDC calculated available storm water storage capacity in Tanks 320 and 330 at 20.2 MM gallons with a normal operating level of 5.5 feet and a high liquid level of 44.5 feet for each tank, even though the tanks are designed with overflow structures at 43 feet. (CIT0090942-943).

²⁴ ENSR reported 18.4 MM gallons of storage capacity in Tanks 320 and 330 with a normal operating level of 5.5 feet and a high liquid level of 41 feet (CIT0088861).

	Primary Pond (pre 1987)	Engineering Science (1987)	BDC (1992)	CITGO (1992)	BDC (1993 Design)	ENSR (1998)	ENSR (2006)
Presumed Storm Water Diverted to Direct Discharge or Held in Area		West End Units			West Tank Farm South Tank Farm Int. Tank Farm Administration	Int. Tank Farm Administration Land Farm (partial)	Power house Employee pkg lot Int. Tank Farm Land Farm (partial)
References	CIT0427194 CIT0258620	CIT0258641, 15 CIT0258624, 30 CIT0258661, 68 CIT0258670	CIT0267467		CIT0090874-76 CIT0090942, 943	CIT0088845 CIT0088857 CIT0088859 CIT0088861, 69	CITGO-LC0000523 to 535

²⁵ Engineering Science determined 47 MM gallons of storm water surge capacity was required as a base case, and recommended 37.8 MM gallons of storm water surge capacity presuming direct discharge of storm water from the west end units (see Table 4.5, CIT0258670; see also CIT0427198).

Water Balances for June 2006 Storm Event

Section E.3, Tables 5 and 6 present my review of CITGO's assessment of the June 19, 2006 storm event and my assessment of likely releases of untreated oily wastewaters to the wastewater storage tank secondary containment dike and the Indian Marais under design storm conditions. In short, that review shows that the available wastewater storage capacity at the time of the June 2006 storm event was well short of the capacity needed to contain the volume of untreated process wastewaters and contaminated storm water that reached the WWT system during the event. The review also shows that the wastewater storage volume required to contain the storm water generated during the June 2006 event was in the range of 39 MM gallons, or roughly equivalent to four wastewater storage tanks the size of T-340.

As noted above, at one point in the design process for the May 1994 wastewater storage and treatment system CITGO wanted 44 MM gallons of storm water capacity to be considered in the design (CIT0267467). Table 11 below shows approximate water balance for the June 2006 storm with CITGO's reported release of 10.9 MM gallons of untreated oily wastewater to the Indian Marais (from Tables 5 and 6) and for the June 2006 storm and the 25-year/24-hour design storm with 44 MM gallons of available wastewater storage capacity, presuming all of that capacity would be available. Table 11 values were calculated the same as in Table 6. The results show no releases of untreated wastewaters to the containment dike or the Indian Marais for the June 2006 storm, and releases of approximately 4.1 MM gallons of untreated wastewater to the containment dike and no releases to the Indian Marais for the 25-year/24-hour design storm. In the case of the 25-year/24-hour design storm, 48.1 MM gallons of storage capacity would have been needed with refinery drainage to the wastewater treatment system as of June 2006.

Table 11
CITGO Petroleum Lake Charles Manufacturing Complex
Water Balance (MM Gallons)
June 18-19, 2006 Storm and 25-Year/24-Hour Design Storm
with 44 MM gallons of Wastewater Storage Capacity

Table 6 Adjusted for CITGO Discharge of 10.9 MM gal and Wastewater Storage Capacity of 44 MM gal

	June 2006 Storm Event w/available wastewater storage capacity	June 2006 Storm Event w/44 MM gallons of wastewater storage capacity	Design 25-yr Storm w/44 MM gallons of wastewater storage capacity
Wastewater pumped to WWT	50.2	50.2	62.5
Wastewater processed at WWT	11.2	11.2	14.4
Required tank storage	39.0	39.0	48.1
Available tank storage	18.9	44.0	44.0
Overflow from tanks	20.1	0.0	4.1
Rainfall to dike during storm	2.5	2.5	3.1
Total in dike	22.6	2.5	7.2
Containment volume	15.8	12.3	12.3
Untreated oily wastewater release to Indian Marais	10.9	0.0	0.0

Notes: (1) For columns 2 and 3 in Table 11, the estimate of secondary containment dike volume (12.3 MM gallons) from CITGO/ReCon March 2008 (CITGO-LC0031045).
 (2) The wastewater processed at WWT for the June 2006 storm event is for an 18-hour period. The wastewater processed for the design 25-year storm is for a 24-hour period.

Based on this review, information presented in Tables 10 and 11 and other information in the record, it is my opinion that CITGO should have installed more than 40 MM gallons of wastewater storage tank capacity when the WWT system was installed in 1994 and completed additional flow reduction projects to provide capacity for containment of the design 25-year/24-hour design storm and to avoid the June 2006 release. This would have required at least two more 10 MM gallon wastewater storage tanks. The installed wastewater storage capacity should address planned and unplanned maintenance outages.

As noted below, CITGO should have also completed a number of dry weather and wet weather wastewater flow reduction projects as part of the installation of the WWT system to partially make up for the shortfall in wastewater storage capacity. CITGO completed installation of a third 10 MM gallon wastewater storage tank (T-340) in December 2007 and expanded the secondary containment dike at a cost of more than \$15.65 million.²⁶ The cost for additional storage capacity to contain a 25-year/24-hour design storm continues to be avoided. For purposes of estimating CITGO's delayed cost of compliance from May 1994 to install 44 MM gallons of wastewater storage capacity, I assigned an investment cost of \$15.65 million each for two additional wastewater storage tanks and associated expansion of the secondary containment dike. Had the flow reduction projects been implemented and adequate wastewater storage capacity been installed there would have been no release from the storm water tanks during the June 2006 storm event.

Operation of Wastewater Storage Tanks

If the wastewater storage tanks (T-320, T-330) had been operated as designed (waste oil and waste solids removed as accumulated) and if the secondary containment dike had integrity, nearly 40 MM gallons of wastewater storage capacity would have been necessary to prevent releases outside the containment dike under conditions observed during the June 2006 storm event. However, the wastewater storage tanks were not operated as designed prior to the June 2006 storm event. CITGO estimated that there were 99,000 up to 135,000 barrels of oil accumulated in T-320 and T-330 and the sludge level was estimated at approximately 8 feet in each tank (CIT0047791, CIT0047792, CIT0476249).

Waste solids removal from the tanks after 1998 was intermittent and little or no waste solids were removed during the period September 2001 to June 2006 (CIT-TETRA000004-11). Intermittent solids processing resumed in 2007. However, solids levels in T-330 were reported at approximately 8 feet as of January 2008 (CITGO-LC0000537) and 9.2 feet in March 2009 (CITGO-LC0023360). Waste oil levels in the tanks were not tracked and waste oil removal equipment was not functional (CIT0047808, CIT0047810). Essentially, CITGO avoided substantial operating and maintenance costs for waste oil removal and waste solids removal from Tanks 320 and 330 as well as costs for processing and disposal of solid residues from at least 2000 to 2006. The yearly avoided waste solids processing costs are estimated to range from approximately \$159,000 to \$543,000 during the July 2000 to June 2007 period (see Exhibit

²⁶ Defendant CITGO Petroleum Corporation's Amended Answers and Objections to Number 8 of the State of Louisiana's First Set of Interrogatories. David Hollis, Manager, Environmental Control Department, Lake Charles Manufacturing Complex, Citgo Petroleum Corporation. October 6, 2009.

K for derivation of yearly estimated costs). The annual cost estimates were prepared based on estimates of the volume (mass) of waste solids collected in the wastewater storage tanks and actual waste solids processing costs reported by Tetra. I could not find sufficient information in the record to estimate avoided annual operating and maintenance costs for removal and processing of waste oil that should have been removed from the wastewater storage tanks, or for off site disposal.

Dry Weather Process Wastewater and Wet Weather Flow Reduction

The simplified water balances presented in Table 11 show that under design storm conditions (25-year/24-hour, 10.25 inches), operation of four 10 MM gallon wastewater storage tanks under specified tank design conditions would not have been sufficient to prevent overflows to the containment dike and possibly to the Indian Marais. Substantial reductions in both dry weather process wastewater flows and wet weather storm flows are needed.

Throughout the process of engineering studies and design development for the WWT system to replace the Primary Pond and the pre-1994 WWT system, as well as after the 1994 system was installed, consultants to CITGO made numerous recommendations to CITGO to reduce dry weather process wastewater flows and to divert clean storm water or to provide facilities to hold storm water in containment structures for purposes of reducing flows to the WWT system during intense storm events. Many of these were relatively low cost projects with fairly substantial flow reduction benefits. Several were considered as projects that were or would be completed for purposes of BDC's 1993 process design for the WWT system. ENSR reported in 1997 that CITGO had implemented direct discharge of storm water from the following areas: West Tank Farm; Clifton Ridge and most of the South Tank Farm (CIT0116916); however several flow reduction projects were not implemented. As an example, the Intermediate Tank Farm project first noted during the initial design of the wastewater storage and treatment facilities had not been completed as of September 2009 (LeBlanc dep. pp. 137-138).

Based on my review of the Engineering Science, BDC, Badgers Engineers and ENSR reports discussed in prior sections, I find the dry weather and wet weather flow reduction recommendations are reasonable, represent good wastewater engineering practice and are well known and well developed technologies within the petroleum refining industry.^{27,28,29,30,31} For example, reuse of sour water stripper bottoms for crude desalting, neutralization of spent caustic streams and isolation of wastewaters containing free hydrocarbons from non-contact cooling waters and uncontaminated storm waters were technologies common in the industry at the time the categorical effluent limitations guideline regulation (40 CFR Part 419) was promulgated by EPA in 1982.

²⁷ *Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Petroleum Refining Point Source Category*, U.S. Environmental Protection Agency, Washington, D.C. April 1974.

²⁸ *Development Document for Effluent Limitations Guidelines, New Source Performance Standards and Pretreatment Standards for the Petroleum Refining Point Source Category*, Effluent Guidelines Division, Office of Water Regulations and Standards, U.S. Environmental Protection Agency, Washington, D.C. EPA 440/1-82/014. October 1982.

²⁹ Langer, B.S., *Wastewater Reuse and Recycle in Petroleum Refineries*, Chemical Engineering Progress, Vol. 75, Issue 5, May 1983.

³⁰ *Best Available Treatment Technology for the Ontario Petroleum Refining Sector*, Prepared for the Ontario Ministry of the Environment, MISA Program, Science Applications International Corporation, Paramus, NJ. July 1992.

³¹ *Water Reuse Studies*, American Petroleum Institute, Washington, D.C. API Publication 949. August 1977.

Based on these considerations, I believe CITGO should have completed a substantial number of the recommended dry weather and wet weather flow reduction projects at the time the WWT system was put in operation (May 1994). Others recommended after May 1994 should have been completed within a reasonable time. For purposes of this review, I identify in Tables 12 and 13, respectively, the dry weather and wet weather flow reduction projects I believe CITGO should have implemented prior to the June 2006 oil release. All of these projects should have been implemented by the time the WWT system was put in operation in May 1994.

The identified dry weather flow reduction projects would have provided a potential flow reduction of 1,267 gpm or approximately 1.75 MM gallons over a 24-hour period. I also considered a dry weather flow reduction project ENSR identified to reduce flow by 50 gpm by installing closed loop cooling systems for analyzers; however, the reported cost was \$700,000 (CIT0110925). I did not include that project in Table 12 because the dry weather flow reduction benefit is relatively low and the cost is relatively high compared to other identified dry weather flow reduction projects. The identified wet weather projects would have provided a reduction of nearly 4.7 MM gallons during the 25-year/24-hour design storm event.

In summary the amount of flow reduction potentially obtainable with the identified dry weather and wet weather projects is 6.5 MM gallons over a 24-hour period for a design storm event. With existing tankage, this approach alone would not prevent releases of untreated wastewaters from the wastewater storage tanks. In fact, CITGO reported that 3.5 wastewater storage tanks would have been necessary to contain the June 19, 2006 storm event within tanks at a starting level of 5.5 feet (CIT1023656, 662).

Table 12
CITGO Petroleum Lake Charles Manufacturing Complex
Delayed Costs for Dry Weather Process Wastewater Flow Reduction

Project	Description	Reported Process Flow Reduction (gpm)	Estimated Cost (year)	Reference
1	Direct discharge blowdown from cooling towers 7, 12 and 502	265	\$75,000 (1998)	CIT0088956 CIT0116897
2	Improve operation of sour water stripper; reuse stripper bottoms for crude desalting	312	\$200,000 (1998) \$326,000 (2007)	CIT0116897 CIT0088967 CIT0244486 CIT0274783
3	Change pump bearings to closed loop circulating cooling systems	200	\$400,000 (1998)	CIT0088956
4	Change air conditioning to closed loop circulating cooling water systems	140	\$210,000 (1998)	CIT0088956
5	Retain cooling tower blowdowns during storm events	300	\$0 (1998)	CIT0088956
	Total	1,217	\$1,011,000	
		1.75	MM Gallons	

Table 13
CITGO Petroleum Lake Charles Manufacturing Complex
Delayed Costs for Wet Weather Storm Water Flow Reduction

Project	Description	Reported Design Storm Flow Reduction (MM gallons)	Estimated Cost (year)	Reference
1	Isolate storm water from Int. Tank Farm (60.36 acres; CITGO-LC 0000527)	3.25 (Note 1)	\$501,000 (2007)	CIT0258614 CIT0090871 CIT0107996 CIT0088523
2	Retain Landfarm storm water (20.95 acres; CITGO-LC 0000527)	1.44	\$20,000 (1998)	CIT0065254 CIT0065281
	Total	4.69	\$521,000	

Note 1: Calculated from information presented in Table A-1 of ENSR 1998 storm water report (CIT0099928-31) with a 25-year/24-hour rainfall of 10.25 inches.

4. Wastewater Storage Capacity to Avoid Releases from the Wastewater Storage Tanks

As noted earlier, ENSR reported in 1998 that the required wastewater storage volume to respond to a 25 year design storm was 34.5 MM gallons (see Table 10). That volume is greater than the current actual working volume of Tanks 320, 330 and 340 combined. Also, as shown in Table 5, approximately 39 MM gallons of wastewater storage capacity was needed to avoid the June 2006 waste oil release and contain untreated oily wastewaters within wastewater storage tanks. Because of the surface area drained to the WWT system at the time, even that volume would not have been sufficient to contain a 25-year/24-hour design storm within the wastewater storage tanks.

Given the lack of adequate wastewater storage capacity, CITGO's current operating practice for managing wastewater flows during intense rainfall events is to utilize the capacity of the secondary containment dike for additional storage of untreated oily wastewaters (CIT0065645, LeBlanc dep., pp 201-202). Under this approach the storage capacity available in the on-line wastewater storage tanks (T-320, T-330, T-340, if all are on line) and storage capacity available in the equalization tank (T-310) would be used first. If the total available capacity of the on-line tanks proves not adequate, any excess wastewater would be diverted to the concrete containment dike for the wastewater storage tanks and the equalization tank. Following is my review of ENSR and CITGO/ReCon reports that address CITGO's current approach of diverting wastewater to the containment dike. CITGO's current operating practice leads to a number of environmental problems.

ENSR, December 2006

In December 2006, after the June 2006 waste oil and untreated oily wastewater release and during construction of T-340, ENSR reported that CITGO has sufficient capacity to contain all of the storm water from a 25-year storm within tanks under the following assumptions (CITGO-LC0000523-535):

- Existing equalization tank from a normal water level of 20 feet to a 41 foot level is available for storm water storage;
- Liquid height in the storm water tanks is 6 feet prior to the storm event;
- Level in the equalization tank is 20 feet prior to the storm event;
- Maximum liquid level allowed in each tank is 41 feet;
- The volume available for storm water storage system consists of two 210 foot diameter storage tanks and one 222 foot diameter tank, plus a 21 foot change in the level for the 210 foot diameter equalization tank;
- Wastewater treatment maximum flow capacity is 12,500 gpm and normal dry weather flow is 7,000 gpm;
- Storm water flow will continue to be processed at the treatment plant until liquid level returns to 6 feet and no additional significant storm event occurs prior to reaching this liquid level.

ENSR reported the available working volume of the three wastewater storage tanks (T-320, T-330, T-340) was 29.9 MM gallons without available volume in the equalization tank (T-310); and, 35.8 MM gallons with available capacity of the equalization tank. This is based on a high liquid level (HLL) for each tank of 43 feet (CITGO-LC0000529, Table 4). ENSR conducted a series of analyses of wastewater tank containment for design storm events using a HLL of 41 feet for the wastewater storage tanks and determined the wastewater flow could be contained within the available tank surge volume provided the HLL could reach 39.8 feet (ENSR, Case 1, Table 5) and 43.0 feet (ENSR Case 2, Table 6). However, CITGO's *Heavy Rain Conditions* standard operating procedure (SOP-432-102, Rev. No. 3, effective 01/30/06, CITGO-LC 0000321-327) calls for diversion from the wastewater storage tanks to the storage tank containment dike at a HLL of 38 feet (CITGO-LC

0000325), as does Rev. 4 of the same procedure (effective date 01/16/07, CIT0065645). As a practical matter, CITGO determined that to avoid overflowing the wastewater storage tanks under intense rainfall conditions, it must begin diverting untreated wastewaters to the containment dike when tanks levels reach 38 feet (CITGO-LC0000325).

Table 14 presents a summary of wastewater storage tank working volumes based on NLL's of six feet and HLL's of 43 feet, 41 feet and 38 feet. As shown, the calculated wastewater storage working volume at a HLL of 38 feet in the wastewater storage tanks and 38 feet in the equalization tank is 25.8 MM gallons without the equalization tank and 30.5 MM gallons with the equalization tank.

Notwithstanding the above calculation of theoretical wastewater storage tank working volumes, some of the tank operating conditions considered and assumed by ENSR for its review were not realistic in December 2006 and are not realistic at this writing:

1. Normal liquid level (NLL) of 6 feet for tanks T320, T-330 and T-340. Although ENSR uses the term NLL as an assumed "normal" wastewater storage tank conditions, for several years prior to and since the June 2006 release CITGO has not maintained an operating liquid level of six feet or less in tanks T-320 and T-330. As of this writing and since the June 2006 release CITGO has not demonstrated it can maintain a NLL of six feet or less in the wastewater storage tanks (CITGO-LC0027142, LeBlanc dep., p.189).
2. ENSR used a high liquid level (HLL) of 43 feet for the wastewater storage tanks and the equalization tank to calculate tank working volumes (see Table 4, CITGO-LC0000529); however, as noted above, CITGO's current heavy rains procedure calls for diversion to the wastewater storage containment dike at wastewater storage tank operating levels of 38 feet. At a HLL of 38 feet, the theoretical change in wastewater storage tank working volume would be a decrease of approximately 4 MM gallons.
3. ENSR considered wastewater treatment system operating capacity at 12,500 gpm. This may be the hydraulic capacity of some units within the end-of-pipe wastewater treatment system; however, with all four of the API oil/water separators on line the design maximum hydraulic capacity is 10,000 gpm. With two DGF units, the design maximum hydraulic capacity is 10,000 gpm. ENSR's recommended operating approach appears to be that up to 5,500 gpm of untreated wastewaters from the wastewater storage tanks would be discharged directly to the aeration tanks, thus bypassing the vapor-controlled API oil/solids separators and the dissolved gas flotation units. This means management of benzene containing wastewaters may not be consistent with CITGO's design plan for compliance with the benzene NESHAPs. Also, the design retention time of the three aeration tanks is approximately 31 hours at 5,500 gpm; 24 hours at 7,000 gpm; 17 hours at 10,000 gpm; and, would be 13.6 hours at 12,500 gpm. This raises concern about compliance with LPDES permit effluent limits at reduced hydraulic retention times. For example, CITGO experienced LPDES permit effluent limit exceedances when it operated the wastewater treatment system in excess of 10,000 gpm for the 18-hour period of the June 2006 storm.
4. Although not stated directly, an implicit assumption by ENSR for processing wastewater at a rate of 12,500 gpm is that all wastewater treatment units are on line at once and in good working order. Given historical and current operations at CITGO that is not realistic.

5. No additional significant storm event occurs prior to returning to a six foot NLL after a storm event. This cannot be guaranteed. Recurring rainfall events are likely from time to time and would present wastewater storage volume shortfalls.

ENSR did not provide an assessment in its December 2006 report that demonstrates the wastewater storage system can be operated as described with respect to storage tank operating levels. ENSR did not provide an assessment that compliance with LPDES permit effluent limits can be assured while operating the WWT system at a flow rate of 12,500 gpm for the period of time necessary to respond to a design storm event and return the wastewater storage and treatment systems to pre-storm operating conditions. Experience shows CITGO has had LPDES permit compliance problems when the wastewater treatment system was operated at high flow rates. Compliance with the benzene NESHAPs was not addressed by ENSR.

ENSR did report that with the above-listed assumptions if one of the 210-foot diameter wastewater tanks (T-320 or T-330) was out of service during a design storm event, approximately 6.3 MM gallons would have to be diverted to the containment dike to avoid overflow of the wastewater storage tanks (CITGO-LC 0000533). ReCon reported in March 2008 that the expected overflow to the containment dike during storage tank maintenance periods would be 11.9 MM gallons (CITGO-LC0031044). Diversions are a likely event. CITGO has noted on several occasions that extended wastewater storage tank outages for tank cleanings and tank inspections are to be expected (CIT0274952, CIT0173303).

A draft Joint Project Study Report prepared by CITGO in May 2007 included the following statement (CIT0173283):

"If no new stormwater tank is added, and one stormwater tank is out of service during a PDB design basis storm (with the recently recalibrated drainage areas) approximately 26.1 million gallons of stormwater will overflow to the diked area around the stormwater tanks. The capacity of the diked area is approximately 12.0 million gallons, so 14.1 million gallons of the overflow in this scenario would reach the Calcasieu River."

In May and October 2007 CITGO reported that each wastewater storage tank is expected to be out of service for 10 months once every ten years (CIT0066248). A fourth storm tank (wastewater storage tank) was cited as the best recommended solution for a number of WWT system issues: inadequate wastewater storage capacity; API oil/solids separator maintenance;; maintenance of the equalization tank; maintenance on the aeration tanks; and, maintenance on the clarifiers. However, despite recommendations from the CITGO project team, the fourth tank was eliminated from consideration by CITGO on or about June 10, 2007 (CIT0298955).

Based on the information presented in Table 14, and considering the current Heavy Rains Procedure that calls for diversion to the containment dike at wastewater storage tank HLLs of 38 feet, the maximum available wastewater storage capacity at this writing is approximately 30.5 MM gallons with design available capacity in the equalization tank, and approximately 25.8 MM gallons without available capacity in the equalization tank. That presumes the wastewater storage tanks are operated at NLL's of six feet or less and no significant oil accumulations. As of this writing, actual wastewater storage capacity is less because the sludge level in T-330 is above the six foot level assumed as the NLL and a layer of floating waste oil is always present in the wastewater storage tanks. As of September 2009, waste solids had not been removed from tank T-330 and the solids level was reported at 8.5 feet (LeBlanc dep. pp. 188-190). As of March 2009, the sludge level was reported at 9.2 feet in T-330; 6.6 feet in T-320 and 7.7 feet in T-340 (CITGO-LC0023360). T-330 was taken out of service for cleaning and operation of the tank was reported to be limited by sludge level.

Since the June 2006 oil release, CITGO reported two releases of untreated oily wastewaters to the secondary containment dike at rainfall intensities less than the 25-year design storm event, one of which occurred after installation of T-340: July 6, 2007³²; July 15, 2008 (CITGO-LC0000554). This indicates diversions to the containment dike will likely occur under less than extreme emergency conditions.

For the July 15, 2008 event CITGO reported that benzene emissions from the diverted water to the containment dike exceeded the reportable quantity (RQ) of 10 lbs for two (2) 24-hour periods beginning at 10 AM on July 15, 2008 (CITGO-LC0000556).

CITGO/ReCon, March 2008

CITGO engaged ReCon to assist CITGO in preparing a Project Design Basis report (Rev. 0, March 14, 2008) for a WWT Improvement Project that includes the following five recommended items (CITGO-LC0031035-74):

- (1) A new oil collection structure on the 006 outfall ditch;
- (2) Improvements to the sewers to the Intermediate Tank Farm area;
- (3) Diversion valves to put storm water into the diked area of the storm water tanks;
- (4) Increasing the capacity of the WWTP storm water tanks external diked area to insure (ensure) containment; and,
- (5) Oily Water Sewer reliability improvements.

The first project is directed at minimizing the potential for oil sheen discharges from LPDES permit Outfall 006. The second project is directed at allowing for containment of storm water in the Intermediate Tank Farm during heavy storm events, a project first recommended during the early 1990's. The third and fourth projects are directed at providing for storm water (untreated refinery wastewater) containment in the containment dike for the wastewater storage tanks when one or more wastewater storage tanks is out of service for maintenance. The fifth project is directed at minimizing the potential for releases of untreated refinery wastewaters from the Oily Waste Sewer pump station to the Calcasieu River. Based on the project descriptions, the first, second and fifth projects appear reasonable and should provide for the intended environmental protections.

As described earlier, I believe that diversion of untreated refinery wastewaters to the wastewater storage tank containment dike during periods of wastewater storage tank maintenance is not a sound wastewater management practice and is contrary to applicable environmental regulations and CITGO's LPDES permit which requires proper operation and maintenance of wastewater treatment facilities at all times. The Project Design Basis report includes the following assumptions, some of which are the same as or similar to those made in the 2006 ENSR report reviewed above:

- A design storm based on a hybrid of the June 19, 2006 storm and the previously considered 25-year, 24-hour storm;
- A dry weather flow rate of 6,500 gpm;
- A wastewater treatment system maximum flow rate of 12,500 gpm;
- Containment of untreated refinery wastewaters within the diked areas until following the storm;

³² Letter from (David Hollis, Manager, Environmental Protection, CITGO Petroleum Corporation, Lake Charles Complex, Lake Charles, LA) to (Dr. Chuck Carr Brown, Office of Environmental Services, Louisiana Department of Environmental Quality, Baton Rouge, LA). July 6, 2007. 1 p.

- Keeping the level in the wastewater storage tanks at or near the low liquid level prior to the storm; and, ongoing removal of waste oil and waste solids from the tanks.

Although not stated by CITGO or ReCon, an important assumption with the above scenario is that all wastewater treatment units must be on line and in good working order to ensure LPDES permit compliance when the wastewater treatment system is operated in excess of the average dry weather flow during wet weather events. Like ENSR in the December 2006 report reviewed above, CITGO and ReCon presume the wastewater storage tanks can be operated at minimum levels, which has yet to be demonstrated. The CITGO/ReCon March 2008 Project Design Basis report did not address compliance with LPDES permit limits when operating the WWT system at a flow rate of 12,500 gpm; compliance with benzene NESHAPs when diverting untreated process wastewaters to the containment dike and directly to the wastewater treatment system aeration basins; RCRA hazardous waste regulations; or, SPCC Plan secondary containment requirements.

Diversion of untreated oily refinery wastewaters to the secondary containment dike for Tanks 310, 320 and 330 was considered by CITGO in January 2003 as an option for expanding wastewater storage capacity, but was rejected by CITGO due to NESHAP compliance issues, environmental and safety concerns (CIT0093255).

Tables 15 and 16 present simplified water balances for the 25-year/24-hour storm. The following assumptions made for Table 15 are the same as those made by ENSR in its December 2006 storm water assessment reviewed above:

- Tanks 320, 330 and 340 operated at design NLL's of 6 feet;
- Tank 310 operated at 20 to 41 feet for wastewater storage;
- Dry weather process wastewater flow of 7,000 gpm;
- No significant rainfall after 25-year/24-hour design storm.

As noted above, I find the assumptions considered by ENSR in December 2006 and by CITGO/ReCon in March 2008 to be collectively optimistic and represent more a "best case" operating scenario than a realistic operating scenario given current conditions and CITGO's history. Nonetheless, for Table 15, the HLLs considered for Tanks 320, 330 and 340 were 41 feet for all tanks, and the wastewater treatment system operating rate was set at 10,000 gpm and 12,500 gpm. Table 16 is based on the same information except that the HLLs were set at 38 feet, which is the level at which CITGO's Heavy Rains procedure calls for diversion from the wastewater storage tanks to the containment dike. Each table presents water balances with all tanks in service and with T-340 out of service. The results of these assessments show that CITGO's current operating approach will surely result in diversions to the containment dike under design storm conditions, particularly when one wastewater storage tank is out of service. There will be some risk of release of untreated oily wastewaters to the Indian Marais from the dike. Again, these assessments were made under optimistic operating assumptions.

Based on consideration of the information presented in Tables 10 and 11; the analysis above, ENSR's 1998 storm water assessment; CITGO's May 2007 assessment of current wastewater storage capacity and wastewater treatment system needs; the expected frequency and duration of planned wastewater storage tank maintenance outages; and, regulatory considerations, my opinion is that CITGO has had inadequate wastewater storage capacity and should have installed at least 40 MM gallons of wastewater storage capacity at the time its wastewater treatment system was commissioned in May 1994. CITGO should now install sufficient wastewater storage capacity and take additional dry weather and wet weather flow reduction measures as necessary to ensure

containment in wastewater storage tanks of wastewaters generated during the 25-year/24-hour design storm.

Table 14
CITGO Petroleum Lake Charles Manufacturing Complex
Assessment of Current Wastewater Storage Capacity
ENSR Corporation Storm Water Management Study
Document No.: 01515-068-100, December 2006
(CITGO-LC0000523-535)

Tank	Tank No.	Ht, ft.	Dia., ft.	NLL, ft.	HLL, ft.	Working Volume (gallons)
<i>Working volume from ENSR Storm Water Management Study, Table 4 (December 2006)</i>						
Equalization	310	50	210	20	43	5,958,788
Wastewater	320	50	210	6	43	9,585,876
Wastewater	330	50	210	6	43	9,585,876
Wastewater	340	50	222	6	43	10,712,705
			Total tank working volume			35,843,244
			Total excluding Equalization Tank			29,884,457
<i>Recalculated with HLL of 41 feet in wastewater storage tanks and equalization tanks</i>						
Equalization	310	50	210	20	41	5,440,633
Wastewater	320	50	210	6	41	9,067,721
Wastewater	330	50	210	6	41	9,067,721
Wastewater	340	50	222	6	41	10,133,640
			Total tank working volume			33,709,715
			Total excluding Equalization Tank			28,269,082
<i>Recalculated based on CITGO Heavy Rains Procedure (diversion to containment dike at 38 feet)</i>						
Equalization	310	50	210	20	38	4,663,400
Wastewater	320	50	210	6	38	8,290,487
Wastewater	330	50	210	6	38	8,290,487
Wastewater	340	50	222	6	38	9,265,042
			Total tank working volume			30,509,416
			Total excluding Equalization Tank			25,846,016

Table 15
 CITGO Petroleum Lake Charles Manufacturing Complex
 Water Balance (MM Gallons)
 CITGO 25-Year/24-Hour Design Storm
 Tanks 320, 330, 340 Operated at NLL (6 feet) & HLL (41 feet)
 Tank 310 Operated at 20 to 41 feet for Wastewater Storage

	All Tanks In Service	Tank 340 Out of Service	Tank 340 Out of Service
Flow processed at WWTP (gpm)	10,000	10,000	12,500
Process water to WWTP (gpm)	7,000	7,000	7,000
Process water to WWTP	10.1	10.1	10.1
Storm water to WWTP	39.2	39.2	39.2
Total water to WWTP	49.3	49.3	49.3
Water processed at WWTP	14.4	14.4	18.0
Required tank storage	34.9	34.9	31.3
Design tank storage (current)	33.7	23.6	23.6
Diversion from WW storage tanks	1.2	11.3	7.7
Rainfall to dike during storm	3.1	3.1	3.1
Total in dike	4.3	14.4	10.8
Containment volume	12.3	12.3	12.3
Release to Indian Marais	0.0	2.1	0.0

Notes: (1) Storm water to WWTP (39.2 MM gallons) from ENSR Dec. 2006 (CIT0225668).
 (2) Secondary containment dike volume (12.3 MM gallons) from CITGO/ReCon March 2008 (CITGO-LC0031045). ReCon also reported secondary containment dike capacity at 12.06 MM gallons in May 2007 (CIT0108016).

Table 16
 CITGO Petroleum Lake Charles Manufacturing Complex
 Water Balance (MM Gallons)
 CITGO 25-Year/24-Hour Design Storm
 Tanks 320, 330, 340 Operated at NLL (6 feet) & HLL (38 feet)
 Tank 310 Operated at 20 to 38 feet for Wastewater Storage

	All Tanks In Service	Tank 340 Out of Service	Tank 340 Out of Service
Flow processes at WWTP (gpm)	10,000	10,000	12,500
Process water to WWTP (gpm)	7,000	7,000	7,000
Process water to WWTP	10.1	10.1	10.1
Storm water to WWTP	39.2	39.2	39.2
Total water to WWTP	49.3	49.3	49.3
Water processed at WWTP	14.4	14.4	18.0
Required tank storage	34.9	34.9	31.3
Design tank storage (current)	30.5	21.2	21.2
Diversion from WW storage tanks	4.4	13.7	10.1
Rainfall to dike during storm	3.1	3.1	3.1
Total in dike	7.5	16.8	13.2
Containment volume	12.3	12.3	12.3
Release to Indian Marais	0.0	4.5	0.9

5. Design and Operating Shortfalls Associated with CITGO's June 2006 Release and LPDES Permit Violations

Section E.4, Tables 7, 8 and 9 set out LPDES permit effluent exceedances reported by CITGO and LPDES Permit violations alleged by LDEQ (Table 7). In its response to LDEQ's Consolidated Compliance Order & Notice of Potential Penalty, CITGO cited circumstances surrounding the effluent limit violations and claimed:³³

"The above referenced incidences are exceptional incidences in which there were unintentional and temporary noncompliances with the effluent limits due to factors beyond CITGO reasonable control. As such they qualify as upsets pursuant to Section III.B.5. of the LPDES Permit."

Because CITGO's wastewater storage and wastewater treatment systems were not designed and operated properly and have proven to be inadequate, I do not believe CITGO can qualify any of the reported LPDES permit effluent limit exceedances as upsets under the terms of the LPDES permit and NPDES permit regulations. Nonetheless, I reviewed the reported exceedances in context of the upset provisions of the LPDES permit. With the possible exceptions noted below, I disagree with CITGO's blanket claim that all of the reported LPDES permit effluent exceedances cited by LDEQ as effluent violations were due to factors beyond the control of CITGO.³⁴ Rather, I believe most of the reported exceedances resulted from CITGO's failure to install certain wastewater storage and treatment facilities and CITGO's failure to operate properly some of the wastewater storage and treatment facilities it did install.³⁵ CITGO's statements are at odds with CITGO's internal assessment of root causes and key facts

³³ Letter from David Hollis (Manager, Environmental Protection, CITGO Petroleum Corporation, Lake Charles Manufacturing Complex, Lake Charles, LA) to Peggy M. Hatch (Department of Environmental Quality, Baton Rouge, LA). *Consolidated Compliance Order & Notice of Potential Penalty, Enforcement Tracking No. MM-CN-06-0058, Agency Interest No. 1250.* May 11, 2007.

³⁴ CITGO claimed that all of the reported exceedances qualify as *upsets* pursuant to Section III.B.5. of the LPDES Permit. I did not review records of notifications and reports that may have been made by CITGO for the reported exceedances to determine whether CITGO met its threshold notification and reporting requirements under terms of the LPDES permit to qualify the exceedances as *upsets*. However, based on the LPDES permit and federal NPDES permit regulations I do not believe CITGO could qualify all of the reported permit limit exceedances as upsets. The LPDES permit (CIT0103612) and the federal NPDES permit regulations at 40 CFR §122.41(n) define *upset* as follows: "*Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operation.*"

³⁵ Given CITGO's high risk design and lack of adequate back-up equipment (lack of adequate wastewater storage capacity, lack of installed spares in WWT system), I do not believe CITGO could qualify any of the exceedances as *bypasses* under terms of the LPDES permit or the federal NPDES permit regulations. 40 CFR §122.41(m)(4)(i)(B) states "(4) Prohibition of bypass. (i) Bypass is prohibited, and the Director may take enforcement action against a permittee, unless: (A) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage; (B) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventative maintenance; and (C) The permittee submitted notices as required under paragraph (m)(3) of this section." LPDES permit LA0005941 contains the same conditions regarding bypasses (CIT0103611).

associated with the June 2006 oil release, which was prepared in July 2006, nearly nine months prior to its May 11, 2007 response to LDEQ's April 9, 2007 Consolidated Compliance Order & Notice of Potential Penalty (see Exhibit I, Tables 1 and 2).

Tables 17, 18 and 19 present my assessment of the LPDES permit exceedances reported by CITGO since installation of the wastewater treatment system in May 1994. Based on information reported by CITGO to LDEQ and U.S. EPA, and review of related information in the record, my opinion is that of the 27 separate events leading to CITGO's LPDES permit effluent exceedances for Outfall 003, perhaps three or four events may be related to events that were beyond the reasonable control of CITGO:

<u>Date</u>	<u>Event</u>
July 1996	Rupture of sour water line in a catalytic cracking unit
September 2001	Explosion and fire in Unicracker Unit
October – December 2005	Hurricane Rita (occurred September 24-25, 2005)
September 2008	Hurricane Ike

CITGO claimed to LDEQ that effluent exceedances reported for October, November and December 2005 were the result of an orderly refinery shut down in anticipation of Hurricane Rita that affected the Lake Charles area on September 24 and 25, 2005. However, CITGO's Waste Water 3rd and 4th Quarter Summary 2005 report included notations that solids in all four API separators had reached critical levels, necessitating cleaning that occurred between July and December 2005. The report also states during the API cleaning process there were several excursions in oil & grease getting through the primary separation system. The excursions were attributed to caustic dumps to the wastewater treatment system. There was a reported 50% reduction in aeration basin processing capability from October to early December because aeration tank T-370 had been out of service since the end of July (header upgrade) and a header failure occurred on aeration tank T-360 upon the restart immediately after Hurricane Rita. Lack of spare API separator capacity and aeration capacity likely contributed to the reported exceedances during this period. Consequently, although the shut down and start-up associated with Hurricane Rita may have been a contributing factor in the reported exceedances, there were other factors at play within CITGO's control.

A March 2005 event associated with a concentrated sulfuric acid spill may or may not have been within the reasonable control of CITGO; however, there is insufficient information in the record for me to form an opinion regarding that event. The other reported LPDES permit effluent exceedances are the result of: (1) prior decisions by CITGO regarding the initial design of the WWT that was put in service in May 1994; (2) lack of timely response by CITGO to recommendations by CITGO consultants and CITGO staff for upgrades to the WWT system after problems and proposed solutions were well understood; and, (3) lack of proper operation and maintenance by CITGO of certain installed pretreatment and WWT system storage and treatment units, particularly the wastewater storage tanks (T-320, T-330) and the API separators (L-201, L-202, L-203, L-204). All of these items were within CITGO's control.

Information provided by CITGO's non-compliance notifications to the LDEQ and U.S. EPA; information contained in a number of engineering reports CITGO commissioned before and after the wastewater treatment system was installed in May 1994, and before and after the June 2006 waste oil and untreated oily wastewater release; and, information contained in numerous CITGO internal reports and correspondence regarding the WWT system show the LPDES permit exceedances (and the June 2006 waste oil and untreated oily wastewater release) were

the result of a number of related design shortfalls that contributed significantly to WWT operating problems and most of the reported effluent exceedances. The reported LPDES permit effluent limit exceedances and near miss situations reflect chronic conditions related to design shortfalls rather than a series of one-time events.

Table 20 presents my assessment of the relationship between the design shortfalls and CITGO WWT operating problems. Also presented are remedies I believe that, if implemented, would have provided for more effective process wastewater and storm water management and wastewater treatment and would have improved CITGO's prospects for maintaining compliance with its LPDES permit and related environmental regulations prior to and during the June 2006 release.

6. Summary of CITGO Avoided and Delayed Costs

Exhibit C is a summary of the costs I believe CITGO either avoided or delayed with respect to wastewater storage capacity and wastewater treatment that led to the June 2006 release.

My opinion is that CITGO should have completed the following pretreatment projects and installed the following equipment items at the time the WWT system was commissioned during May 1994:

<u>Equipment Item or Project</u>	<u>CITGO Cost Estimate (year)</u>
Third and fourth wastewater storage tanks	\$31,300,000 (2006-2007)
Direct discharge blowdowns from CT's 7,12 & 562	\$ 75,000 (1998)
Recycle sour water stripper bottoms to crude desalters	\$ 326,000 (2007)
Change pump bearings to closed loop cooling	\$ 400,000 (1998)
Charge air conditioning to closed loop cooling	\$ 210,000 (1998)
Isolate storm water from Intermediate Tank Farm	\$ 501,000 (2007)
Retain Land Farm storm water	\$ 20,000 (1998)
Caustic neutralization unit	\$ 2,700,000 (1994)
Direct streams containing free oil to dedicated API separators	\$ 263,000 (1998)
One API oil/solids separator	\$ 1,726,000 (2007)
One dissolved gas flotation (DGF) unit	\$ 3,320,000 (2007)

Furthermore, I believe CITGO should have installed the following equipment items by the dates noted in the paragraphs below to ensure adequate treatment capacity to operate at higher waste loadings and at higher wastewater flow rates:

<u>Equipment Item or Project</u>	<u>CITGO Cost Estimate (year)</u>
One API oil/solids separator	\$ 1,726,000 (2007)
Upgrade two aeration tanks (fine bubble diffusers)	\$ 1,127,000 (2007)

For purposes of economic benefit calculations I specified May 1994 as the date when the fifth API oil/solids separator should have been installed. This would have provided four separators on line and one in-line spare to process a then maximum design hydraulic flow of 10,000 gpm and have one spare to address frequent maintenance outages. A sixth API oil/solids separator is specified to ensure at least five are available to process CITGO's current design hydraulic maximum wastewater treatment system flow rate of 12,500 gpm. Hydraulic design specifications for these units (Table 2) are an average design flow of 1,750 gpm and a maximum hydraulic flow of 2,500 gpm. Given the likelihood that one API oil/solids separator will

be off line for maintenance at any given time, six units are necessary to ensure five will be on line when needed to process higher than average flow rates (e.g., 12,500 gpm). I believe the sixth API separator should have been installed at the same time the third clarifier (L3) was installed in May 2005 to address higher flows CITGO anticipated with planned refinery expansion projects.

I specified a third dissolved gas flotation unit as an essential spare that should have been installed in May 1994. If CITGO plans to process as much as 12,500 gpm in response to heavy rainfall events, having one DGF out of service would require storage of wastewater in excess of the capacity of the one DGF in the swing tank (T-320) or the wastewater storage tanks, thus consuming wastewater storage capacity that would otherwise be required to respond to a storm event.

Three aeration tank upgrades with fine bubble diffusers are specified to provide for short-term dry weather flow operation with two aeration tanks when one tank is down for maintenance. This is a lower cost alternative than installing a fourth aeration tank.

7. Recommended Corrective Measures

In my opinion the following actions are needed to address the June 2006 release and to prevent future violations:

Wastewater Storage Capacity

- Within 6 months, complete with assistance from independent consultants an engineering study to evaluate possible dry weather and wet weather flow reduction measures, including additional separation of process wastewater and storm water, where feasible. Within 12 months, complete implementation of cost-effective dry weather and wet weather flow reduction measures.
- Within 6 months, complete with assistance from independent consultants reliable estimates of storm water generated from the 25-year/24-hour design storm. Submit estimates to EPA for review.
- Within 24 months, install supplemental wastewater storage capacity to contain in tanks the combination of process wastewaters and storm waters generated from the 25-year/24-hour design storm. Install corresponding supplemental secondary containment capacity.
- Within 24 months, complete tank integrity testing for Tanks T-310, T-320 and T-330 per API standards.
- Effective immediately and continuing thereafter, remove floating waste oil in Tanks T-320, T-330 and T-340 to minimum levels consistent with effective operation of oil removal and oil processing equipment.
- Effective within 12 months and continuing thereafter, achieve and maintain normal liquid levels of six feet or less in tanks T-320, T-330 and T-340 under non-storm conditions.

- Effective within 12 months, achieve and maintain minimum sludge (waste solids) levels in tanks T-320, T-330 and T-340 by more or less continually removing waste solids.

Wastewater Treatment

- Within 12 months complete engineering investigations of feasible COD reduction measures. Within 24 months complete cost effective COD reduction measures.
- Within 18 months, install two API oil/solids separators equivalent to existing API oil/solids separators as in-line operating units and spares. In addition, review and consider installation of oil/solids separation equipment upstream of the existing API oil/solids separators for scalping heavy oil/solids loadings. The installed capacity of oil/solids separators must be sufficient to process anticipated waste solids and waste oil loadings from the dry weather process wastewater flow, from storm flow and from the wastewater storage tanks.
- Within 18 months, install a third dissolved gas flotation (DGF) unit as an in-line operating unit and spare for supplemental oil/solid separation ahead of biological treatment.
- Within 12 months, ensure there is sufficient capacity in the Tetra residuals processing area to handle anticipated waste solids and waste oil loadings.
- Within 12 months, install fine bubble diffusers in aeration tank T-350.
- Ensure wastewater temperature entering the biological treatment system is within design standards by: (1) installing permanent additions to the wastewater treatment system cooling capacity; (2) annually, installing rental cooling tower units for wastewater treatment system during warm weather months; and/or (3) installing supplemental wastewater cooling capacity at the refinery operating units.

Indian Marais

- Within 3 months, submit to LDEQ and EPA for review and approval a quality assurance project plan for characterizing levels of toxic and hazardous substances associated with releases of CITGO's waste oils and untreated petroleum refinery wastewaters to the Indian Marais during the June 2006 event.
- Within 12 months after approval of the above-referenced study plan, complete implementation of the study. Within three months from completion of the study, submit a report of the study to LDEQ and EPA.
- Complete remediation of the Indian Marais in coordination with LDEQ and EPA based on the study results at a schedule to be determined.

Table 17
 CITGO Petroleum Lake Charles Manufacturing Complex
 Assessment of Reported LPDES Permit Exceedances for Outfall 003
 CITGO Reported Exceedances (May 1994 to December 2000)

Date	Parameter	Permit Limits (lbs/day ex. pH)	Sample Value (lbs/day ex. pH)	CITGO Comments	Assessment
Jul 1994	Oil & Grease (daily max.)	2,459	6,929	Unknown cause. Possible operational problem during lining out new WWTP. Discharge concentration does not appear possible based on prior and subsequent O&G results three days before and three days after (CIT0180601).	Possibly related to pretreatment issues (caustic neutralization, API separators)
Nov 1994	TSS (daily maximum)	5,402	6,175	No apparent cause. Operational problems with lining out new WWTP. Clarifier operation less than satisfactory; carryover of solids (CIT0180597).	Likely related to pretreatment issues (caustic neutralization, API separators) and carryover of biological solids from clarifiers to Settling Pond.
	TSS (daily maximum)	5,402	10,741	Same as above (CIT0180593).	
	TSS (monthly average)	3,440	4,636		
Dec 1994	TSS (daily maximum)	5,402	15,172	Same as above (CIT0180589).	
	TSS (monthly average)	3,440	4,363		
Mar 1995	Zinc (monthly average)	24	28.8	Possible upset in cooling water systems which affected heat exchangers (CIT0180581).	Cause uncertain.
	Zinc (daily maximum)	12	12.6		
July 1995	Sulfide (daily maximum)	46	51	Removal of water from settling basin in preparation for maintenance activities (CIT0180565)	Likely related to carryover of biological solids from secondary clarifiers to Settling Pond.
	Sulfide (daily maximum)	46	50	Upset in unnamed refinery unit (CIT0180561)	Likely related to carryover of biological solids from secondary clarifiers to Settling Pond.
	Ammonia (daily maximum)	2,640	2,996	Extremely hot humid weather limited ability to keep temperature of biological treatment section within design temperature (CIT0180562)	Likely related to hydraulic design capacity of cooling towers and fouling of heat transfer surfaces.
	Sulfide (monthly average)	21	27	Upset in unnamed refinery unit (CIT0180561)	Likely related to carryover of biological solids from secondary clarifiers to Settling Pond.
	Ammonia (mon. average)	1,209	1,238	Extremely hot humid weather limited ability to keep temperature of biological treatment section within design temperature (CIT0180562).	Likely related to hydraulic/thermal design capacity of cooling towers and fouling of heat transfer surfaces.

Date	Parameter	Permit Limits (lbs/day ex. pH)	Sample Value (lbs/day ex. pH)	CITGO Comments	Assessment
Aug 1995	Ammonia (daily maximum)	2,640	2,793	Upset condition in "A" sour water stripper unit on August 22. Failure in startup connection block valve (metal obstruction). Phone notification to U.S. EPA Region VI on August 23. Believes meets the definition of an upset under LPDES permit (CIT0180538).	May not qualify as an <i>upset</i> because of improperly designed treatment facilities, inadequate treatment facilities or careless or improper operation.
	Ammonia (daily maximum)	2,640	3,824	Continued upset of WWTP due to above normal temperatures in July and high hydraulic loading flows from Tropical Storm Dean and increasing capacity to store rainfall in anticipation of Hurricane Erin, which was being predicted to strike the Louisiana coast (CIT0180548-9).	Rainfall reported at LC Port Weather Station was zero inches on July 28; 0.52 inches on July 29; 0.21 inches on July 30; 0.47 inches on July 31; 1.74 inches on August 1; 2.54 inches on August 2; and, zero inches on August 3, 1995. The total rainfall over this period is 5.48 inches, well below the design 25-yr/24-hr storm. Likely related to insufficient storm water storage capacity and hydraulic/thermal design capacity of cooling tower.
	Sulfide (daily maximum)	46	70		
Jun 1996	TSS (daily maximum)	5,402	5,905	Overloading the WWTP from heavy rain for three preceding days to June 20, 1996. Plan to divert to surge pond to prevent further exceedances (CIT0074769).	Rainfall reported at LC Port Weather Station was zero inches on June 17 and 18; 0.85 inches on June 19; 3.05 inches on June 20; 0.63 inches on June 21; and zero inches on June 22, 1996. Total rainfall over this period was 4.73 inches, well below well below design 25-yr/24-hr storm. Related to insufficient storm water storage capacity.
	Sulfide (daily maximum)	46	279	Sulfide released from bottom sludges at WWTP. Believed to be result of reduction of sulfates to sulfides via anaerobic micro-organism activity in WWTP basins (CIT0074766).	Likely related to carryover of biological solids from secondary clarifiers to Settling Pond. See above.
	Sulfide (monthly average)	21	39		
July 1996	Ammonia (daily maximum)	2,640	3,112	Rupture of sour water line in a catalytic cracking unit. Not possible to reduce flow at WWTP to address increased ammonia loading. Phone notification to U.S. EPA Region VI. Believes meets definition of an upset under LPDES permit (CIT0180473).	May not qualify as an <i>upset</i> because of improperly designed treatment facilities, inadequate treatment facilities or careless or improper operation.
Sep 1996	TSS (daily maximum)	5,402	8,078	Greater than expected COD loadings as well as possible high levels of oil & grease from process operations over the weekend; because of an increases sludge buildup in the settling basin, TSS removal efficiency has been reduced (CIT0180459).	Related to pretreatment issues (caustic neutralization, API separators) and carryover of biological solids from clarifiers to Settling Pond.

Date	Parameter	Permit Limits (lbs/day ex. pH)	Sample Value (lbs/day ex. pH)	CITGO Comments	Assessment
Dec 1999	Sulfide (daily maximum)	46	63	Natural phenomenon beyond the control of CITGO causing liberation of sulfides. CITGO maintained liberation of sulfides constituted an upset condition (CIT0186742).	Likely related to carryover of biological solids from secondary clarifiers to Settling Pond.
Aug 2000	TSS (daily maximum)	5,402	6,129	<p>Higher than normal temperatures affected viability of activated sludge treatment system; one of three aeration tanks out of service for extended repairs; operational difficulties in refinery units caused swings in pH. DMR cover letter (September 18, 2000).</p> <p>See also CIT0113724, July 2000 WWTP Performance report. Cites volume of water being processed, aeration loading limitation, biomass health, high aeration temperature and high influent pH as reasons for drop in COD removal efficient from 90% to below 75%. Phenol and sulfide breakthrough at clarifiers required use of all three chlorine dioxide units.</p>	Related to insufficient storm water storage capacity, hydraulic/thermal design capacity of cooling tower and pretreatment issues (caustic neutralization, API separators) and carryover of biological solids from clarifiers to Settling Pond.

Table 18
 CITGO Petroleum Lake Charles Manufacturing Complex
 Assessment of Reported LPDES Permit Exceedances for Outfall 003
 LaDEQ Consolidated Compliance Order and Notice of Potential Penalty
 (September 2001 to August 2006)

Date	Parameter	Permit Limits (lbs/day ex. pH)	Sample Value (lbs/day ex. pH)	CITGO Comments	Assessment
Sept 2001	Ammonia (daily average)	1,209	5,279	As a result of an explosion and fire the evening of September 21 in the Unicracker Unit, materials released as a result of both the explosion/fire and the large amount of foam used in fire-fighting activities placed a heavy load on the WWTP. There was also a significant increase in flow to the WWTP from the use of fire nozzles and monitor units in fighting the fire. The increase in chemical loading and flow resulted in the loss of biological treatment activity.	May not qualify as an <i>upset</i> because of improperly designed treatment facilities, inadequate treatment facilities or careless or improper operation.
	Ammonia (daily maximum)	2,640	21,354		
	BOD (daily average)	4,178	13,013		
	BOD (daily maximum)	7,853	95,229		
	Sulfides (daily average)	21	340		
	Sulfides (daily maximum)	46	1,774		
	TOC (daily average)	6,283	9,510		
	TOC (daily maximum)	11,323	56,567		
	TSS (daily maximum)	5,402	6,406		
Oct 2001	Ammonia (daily maximum)	2,640	3,283	See also CIT0112884. Cites toxic conditions from Unicracker incident essentially wiped out bio-system from September 21 to October 5.	
Apr 2002	Sulfides (daily maximum)	46	65.9	<p>A heavy rainfall of approximately 4 inches on Apr. 7-8, 2002 resulted in excessive carryover and loss of biomass from the clarifiers. Following the rain event, elevated sulfides and ammonia loadings to the aeration system placed additional stress on the remaining biomass.</p> <p>See also DMR cover letter (May 13, 2002). Cites unscheduled clarifier outage week of April 14, 2002.</p>	<p>Rainfall reported at LC Port Weather Station was 3.67 inches for April 5 to 11, 2002. Maximum day was April 9 at 2.33 inches, well below design 25-yr/24-hr storm.</p> <p>Exceedances attributed to lack of adequate storage capacity and pretreatment (neutralization of spent caustics, API separators) and inadequate biological treatment system clarification capacity.</p>
July 2002	TSS (daily maximum)	5,402	6,003	<p>As a result rainfall on June 27, 2002, excessive carryover and loss of biomass from the clarifiers lead to this exceedance.</p> <p>See also DMR cover letter (August 13, 2002). Cites storm flow of July 27 washed out approximately 50% of normal activated sludge and that fresh bugs were added to rebuild biomass for treatment.</p>	<p>Rainfall reported at LC Port Weather Station was 9.23 inches for June 24 to 30, 2002. Maximum day was June 27 at 4.00 inches, well below design 25-yr/24-hr storm.</p> <p>Exceedances attributed to lack of adequate storage capacity and inadequate biological treatment system clarification capacity.</p>

Date	Parameter	Permit Limits (lbs/day ex. pH)	Sample Value (lbs/day ex. pH)	CITGO Comments	Assessment
Aug 2002	TSS (daily maximum)	5,402	7,599	As a result of heavy rainfall on Aug 15, 2002 and outage of one aeration tank. See also CIT0113788. Biosystem under stress prior to event (CIT0113793). Corporate guidance to determine management of water during emergency situation: LPDES violation vs. Benzene NESHAPs (CIT0113795).	Rainfall reported at LC Port Weather Station was 5.51 inches for August 12 to 18, 2002. Maximum day was August 16 at 2.72 inches, well below design 25-yr/24-hr storm. Exceedances attributed to lack of adequate storage capacity and pretreatment (neutralization of spent caustics, API separators); aeration tank outage; and, inadequate biological treatment system clarification capacity.
	TOC (daily maximum)	11,323	11,960		
Mar 2005	Ammonia (daily average)	1,209	1,374	As a result of a sulfuric acid leak, biological treatment activity was impacted. See also CIT0192368-9; CIT0112328-41 and CIT0077785.	Acid Plant unable to contain 98% acid leak from TK-5 (CIT0192329). Pretreatment, wastewater storage and wastewater treatment systems overwhelmed by massive leak; some confusion between vacuum truck operators and WWTP personnel for providing caustic for neutralization. Possible secondary containment issue for TK-5 at Acid Plant.
	Ammonia (daily maximum)	2,640	3,689		
	BOD (daily maximum)	7,583	9,801		
	pH (excursions > 60 min.)	0	2		
	pH (excursions, total min.)	446	467		
	Sulfides (daily maximum)	46	48		
	TOC (daily maximum)	11,323	21,117		
	TSS (daily average)	3,440	4,828		
Aug 2005	TSS (daily maximum)	5,402	15,045	Excessive anaerobic activity within the Settling Basin and Polishing Pond. See also CIT0192120-1; CIT0069351.	Related to pretreatment issues (caustic neutralization, API separators) and carryover of biomass from clarifiers to Settling Pond
	Sulfides (monthly average)	25.3	51		
	Sulfides (weekly average)	56.3	168		
Sep 2005	TOC (monthly average)	9,941	10,642	As a result of the start up of the Purge Treatment Unit for the FCCU Wet Gas Scrubbers. See also CIT0077883.	Related to pretreatment issues (caustic neutralization, API separators) and carryover of biomass from clarifiers to Settling Pond
	TOC (monthly average)	9,941	15,300		
	TSS (weekly average)	6,188	9,028		
Oct 2005	Ammonia (monthly avg.)	1,813	1,822	October ammonia exceedances: As a result of the start up of the Purge Treatment Unit for the FCCU Wet Gas Scrubbers. See also CIT0077883.	Start-up issues associated with return to operations after Hurricane Rita shutdown.
	Ammonia (weekly average)	3,960	7,866		
Nov 2005	Ammonia (weekly average)	3,960	4,253	Reported at page 9 of CITGO May 11, 2007 response to LADEQ CCO & NOPP for exceedances in October, November and December 2005: Hurricane Rita forced a complete and orderly shutdown of LCMC and subsequent loss of utility power. CITGO submitted notification of Upset Conditions in accordance with LPDES LA0005941. The Governor issued a Declaration of Emergency and Administrative Order for all areas affected by Hurricane Rita. See also CIT0077847.	CITGO quarterly wastewater report for the 3 rd and 4 th quarter 2005 reports API separator and aeration tanks were out of service during that period (CIT0087633-645).
	BOD (monthly average)	4,518	4,553		
	TOC (monthly average)	9,941	11,713		

Date	Parameter	Permit Limits (lbs/day ex. pH)	Sample Value (lbs/day ex. pH)	CITGO Comments	Assessment
Dec 2005	Oil & Grease (mon. avg.)	1,485	1,635	Reported at page 9 of CITGO May 11, 2007 response to LADEQ CCO & NOPP that December 2005 oil & grease exceedance was attributable to Hurricane Rita (late September 2005 event). No reason provided for oil & grease exceedance provided with DMR report for December 2005 (see CIT0069236).	Related to pretreatment issues (caustic neutralization, API separators)
Feb 2006	Ammonia (mon. average)	1,813	1,907	No report	
May 2006	Sulfides (monthly average)	25.3	26	No report	
Jun 2006	Ammonia (weekly average)	3,960	6,165	As a result of Flash Flood 06-19-06	CITGO reported release from wastewater treatment plant was preventable (CITGO-LC0000545).
	Oil & Grease (mon. avg.)	1,485	1,656		
	Sulfides (monthly average)	25.3	60		
	Sulfides (weekly average)	56.3	209		
	TSS (monthly average)	3,961	7,401		
	TSS (weekly average)	6,188	21,840		
Jul 2006	BOD (monthly average)	4,518	8,833	As a result of upset conditions at CV-1 desalter. See CIT0192675 that describes exceedances as related to: (1) heavy rains requiring higher than normal flow through WWT; (2) caustic spill at TK 187; and, (3) upset conditions at CV-1 Desalter. Caustic spill and CV-1 upset cited as causing elevated oil and grease throughout WWT unit. See also CIT0078063 that cites high influent pH and CV-1 upset.	Related to lack of adequate storage capacity and pretreatment issues (caustic neutralization, API separators) and carryover of biomass from clarifiers to Settling Pond
	BOD (weekly average)	8,863	12,514		
	Oil & Grease (mon. avg.)	1,485	3,420		
	Oil & Grease (wkly avg.)	2,824	4,899		
	Sulfides (monthly average)	25.3	124		
	Sulfides (weekly average)	56.3	344		
	TOC (monthly average)	9,941	12,771		
	TSS (monthly average)	3,961	7,022		
Aug 2006	TSS (weekly average)	6,188	20,078	Excessive anaerobic activity within the Settling Basin and Polishing Pond.	Related to pretreatment issues (caustic neutralization, API separators) and carryover of biomass from clarifiers to Settling Pond
	Sulfides (weekly average)	56.3	60		

Table 19
 CITGO Petroleum Lake Charles Manufacturing Complex
 Assessment of Reported LPDES Permit Exceedances for Outfall 003
 CITGO Reported Exceedances (January 2007 to August 2009)

Date	Parameter	Permit Limits (lbs/day ex. pH)	Sample Value (lbs/day ex. pH)	CITGO Comments	Assessment
Jun 2007	Ammonia (daily maximum)	3,960	8,930	No report	
Jul 2008	Ammonia (daily average)	1,813	2,063	Elevated ammonia loading was a result of a plant-side in nitrogen from purchased crude (August 13, 2008; July 2008 DMR report).	Magnitude of exceedances suggest ammonia controllable through operation of WWT system. Possibly related to biological treatment system operating temperature and oxygen deficit.
	Ammonia (daily maximum)	3,960	4,499		
Sep 2008	Bypass of 139,000 gallons of untreated process water and contaminated storm water		Not monitored	<p>Hurricane Ike forced a partial and orderly shutdown of the CITGO-LCMC. Due to the shutdown and startup of the facility upset conditions of CITGO's wastewater treatment plant occurred. A partial bypass of treatment during the event was necessary. A power failure at the wastewater treatment plant caused a partial bypass of wastewater into the Calcasieu River and CITGO's Surge Pond. Reported bypasses:</p> <p>To C. River: 129,000 gal process water To C. River: 10,000 gal cont. storm water To Surge Pond: 34,500 gal contaminated storm water (Oct. 14, 2008; Sept. 2008 DMR report)</p>	<p>May not qualify as <i>upset</i> under terms of LPDES permit. Assessment may be possible based on review of incident report.</p> <p>Evaluation of alternate power supply for Lift Station recommended in 1998 (CIT0120793-96)</p>
Oct 2008	Ammonia (daily maximum)	3,960	4,897	Upset at A sour water stripper unit	Magnitude of exceedances suggest ammonia may have been controllable through operation of WWT system. Possibly related to biological treatment system operating temperature and oxygen deficit.

Table 20
CITGO Petroleum Lake Charles Manufacturing Complex
Design Shortfalls, Wastewater Treatment System Operating Problems and Identified Remedies

	Design Shortfall	Wastewater Treatment System Operating Problem	Identified Remedy
1.	Storm water storage capacity	<ul style="list-style-type: none"> • Operation of WWT system at greater than optimum flow rates (i.e., > 7,000 gpm). • Hydraulic stress on API separators; high solids loading and oil carry over through DGFs to biotreatment units. • Wash out of microorganisms from clarifiers. • Excess sediment in Settling Basin, Primary Pond • Generation of sulfide in Settling Pond sediments • Unpermitted discharges under LPDES permit • Effluent limit exceedances for TSS, sulfide, other 	<p>Additional storm water storage capacity</p> <p>Dry weather and wet weather flow reduction</p> <p>Proper operation of wastewater storage tanks (waste oil, waste solids removal)</p>
2.	Process water pretreatment	<ul style="list-style-type: none"> • Solubilization of free hydrocarbons (oil) in untreated wastewaters in collection and storage systems leading to excess COD loadings to biotreatment • Excess oil to WWT system • Excess COD to WWT system 	<p>Segregation and neutralization of spent caustic streams</p> <p>Isolation and treatment of low volume streams containing heavy free oil</p> <p>COD reduction projects</p>
3.	Number of API oil/solids separators and lack of installed spares	<ul style="list-style-type: none"> • Oil carry over through DGFs to biotreatment units • Oil coating biomass retards oxygen transfer; toxicity • Excess COD loading to biotreatment • Foaming at aerations tanks (T-350, T-360, T-370) • Effluent limit exceedances for O&G, TOC, other 	<p>Additional API oil/solids separators and oil/solids removal upstream of API oil/solids separators to scalp heavy oil/solids loadings</p>
4.	Number of dissolved gas flotation (DGF) units	<ul style="list-style-type: none"> • See above. 	<p>Additional DGF unit</p>
5.	WWT system cooling tower design	<ul style="list-style-type: none"> • Stress on biotreatment system at operating temperatures > 100°F • Effluent limit exceedances for ammonia-N, other 	<p>Additional WWT system cooling capacity and/or thermal source reduction within refinery</p>
6.	COD loading exceeding design basis	<ul style="list-style-type: none"> • Inability to provide sufficient oxygen for bio-oxidation of organic and nitrogenous load to WWT system • Effluent for ammonia-N, BOD, TOC, sulfides 	<p>Additional aeration capacity. Fourth aeration basin and/or improve oxygen transfer in existing aeration tanks</p>
7.	Biological treatment clarification capacity	<ul style="list-style-type: none"> • Wash out of biosolids at flow rates exceeding 7,000 gpm; inability to maintain required populations of micro-organisms for effective treatment • Effluent limit exceedances for TSS, sulfide, other 	<p>Additional clarification capacity – third clarifier (L3)</p>